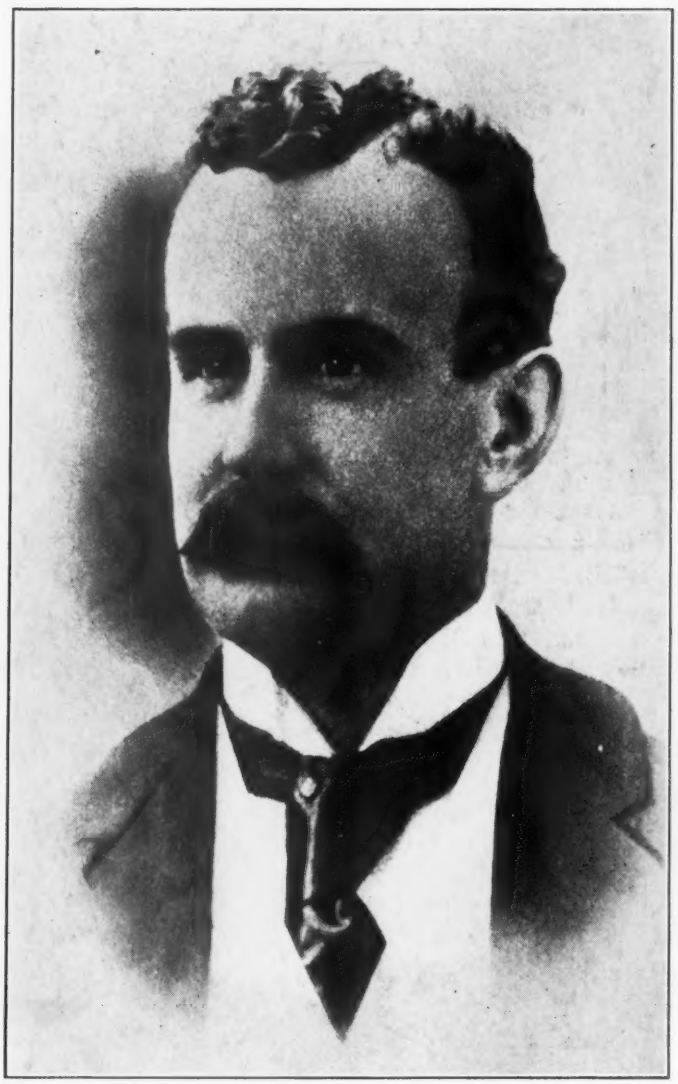
THE BULLETIN

OF THE

AMERICAN CERAMIC SOCIETY

Volume 16 APRIL, 1937 Number 4



Walter Scott Lenox

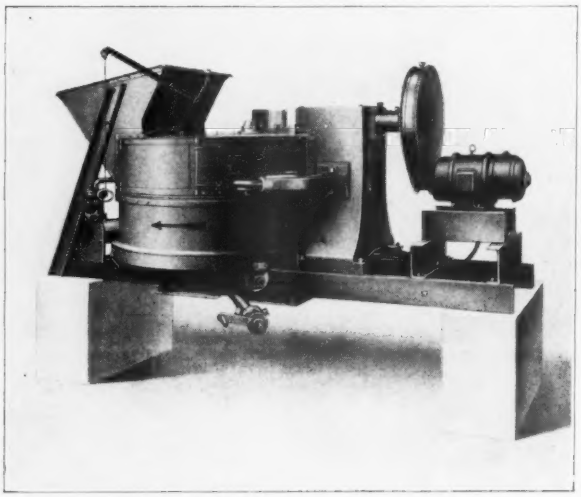
See page 177 for story of Walter Scott Lenox

Learn all you can about your product . . . take an active interest in your Trade Association

Lancaster

THE first real forward step in the preparation of Ceramic Bodies has been made possible since air floated clays and Lancaster Mixers are both obtainable.

Blungers, agitators, filter press pumps and filter presses, are eliminated by the Lancaster Mixing System.



Lancaster Mixers are fully enclosed, thus reducing dust losses and protecting workmen from inhaling injurious and discomforting dusts.

Body batches of air floated clay with standard flint and feldspar are mixed in six minutes with about 17% of water. In these six minutes the plasticity is equal to blunging, filter pressing and aging for 24 hours. An absolutely uniform color distribution is obtained in cobalt stain, using only 0.25% to .050% stain. This stain is mixed dry with a body for two minutes; water is then added and mixed for three minutes.

Lancaster PRODUCTS

Soft Mud Brick Machines—Automatic Pallet Car Loaders	Bulletin 10
Clay Cleaners—Granulators—Pug Mills—Disintegrators—Crushers	Bulletin 20
Mold Sanders—Sand Dryers—Sand Sifters—Winding Drums	Bulletin 30
Brick Barrows and Brick Trucks	Bulletin 40
Maple Molds for Building Brick and Fire Brick	Bulletin 40-A
Martin-Lancaster Steam Pipe Rack Brick Dryers	Bulletin 50
The Lancaster Scientific Counter-Current Rapid Batch Mixer	Bulletin 70-B
The Lancaster Brick Grab	Bulletin 80

LANCASTER IRON WORKS, INC., LANCASTER, PENNA.

BRICK MACHINERY AND MIXER DEPARTMENT JAMES P. MARTIN, *Manager*

THE BULLETIN OF THE AMERICAN CERAMIC SOCIETY

Volume 16 April, 1937 Number 4

CONTENTS

Papers 135

Brick Masonry in State Highway Bridges in Ohio—J. C. Merrell ... 135
Checker Brick in Open-Hearth Service—W. C. Buell, Jr ... 139
The Influence of Material, Shape, and Size of Checker Brick on Heat Transfer in Regenerators—J. D. Keller 144
Refractories Division Fall Meeting Discussion ... 152
Henry LeChatelier: I, His Life and Work—Alexander Silverman ... 155

Activities of the Society 164

Presidential Address—F. C. Flint ... 164
Induction Ceremony for Officers of the Society for 1937-38—A. Silverman ... 166
Officers Inducted at Thirty-Ninth Annual Meeting ... 166
Photographs of Society Officers: R. B. Sosman, V. V. Kelsey, C. F. Tefft, C. E. Bales, L. E. Barringer, H. G. Wolfram ... 167-68
Educational Training and Employment Status of Members of the American Ceramic Society—E. E. Marbaker 168
Mineral Industries Education Division, A.I.M.M.E., Report—A. F. Greaves-Walker ... 169
Audit Report of Society for 1936 ... 170
Membership Status and "Good Ship Ceramics" ... 171
New Members—Roster Changes ... 172
Membership Workers' Record ... 173
Necrology: J. C. Parkinson, Leonard Bishton-Botfield, G. W. Anderson, and F. M. Ransbottom ... 173
Local Section News ... 174
Central Ohio, Michigan-Northwestern Ohio, St. Louis ... 174
Baltimore-Washington ... 175
Reports of Industrial Divisions ... 175
Structural Clay Products Officers ... 175
Enamel Division Report of Committee on Standardization of Tests ... 175
Proposed Amendments to the Constitution ... 176

Communications—Ceramic History 177

Walter Scott Lenox—G. S. Holmes ... 177

Notes and News 180

Research Fellowships in Coal and Nonmetallics ... 180
Ceramic Short Course at Ohio State University ... 180
Summer Course on "Nature of Clay and Plasticity" at Massachusetts Institute of Technology ... 180
Exhibit of American Ceramics in Copenhagen Press Report—A. W. Olmsted ... 181
Porcelain Enamel Institute Annual Meeting ... 182
Silica Research in European Laboratories ... 182
Foundrymen's Association Annual Meeting ... 182
New Uses of Spodumene ... 182
Pittsburgh-Corning Corporation ... 183
Message to Society Members and Prospective Members ... 184

Advertisers' Index ... 4

Buyers' Guide ... 7

Publication Office: 20th & Northampton Sts., Easton, Pa.
Editorial and Advertising Office: 2525 N. High St., Columbus, Ohio.
Executive Office: 2525 N. High St., Columbus, Ohio.
Committee on Publications: J. D. Sullivan, *Chairman;* R. F. Sherwood, E. de F. Curtis, W. W. Winship, Ross C. Purdy.

Entered as second-class matter at the post office at Easton, Pa., under the act of March 3, 1879. Published monthly.
Subscription $1.50 a year. Single numbers twenty-five cents
(Foreign and Canadian postage, 50c additional on subscriptions)

(Copyright 1937, American Ceramic Society, Inc.)

EDGAR NO-KARB CLAY is a proven product—we believe an outstanding development in the history of domestic clay production . . .

Let us send you samples and information.

EDGAR PLASTIC KAOLIN CO.
Home Office—Metuchen, N. J.

EDGAR BROTHERS CO.
New York Office—50 Church St.

Mines in Georgia and Florida

Numerical Documentation

THE ANNUAL TABLES OF CONSTANTS (A.T.C.)
AND NUMERICAL DATA

Chemical, Physical, Biological, and Technological
collect, classify, and publish, since 1910, everything in Pure and Applied Natural Sciences capable of being expressed by a number

(For the period 1910–1929) the **A.T.C.** *complete and*
(since 1928) *continue* the International Critical Tables (I.C.T.)

The **A.T.C.** are absolutely necessary to all scientists.

They represent
the only one complete documentation—the most inexpensive—the easiest to consult
owing to an *Index* systematically arranged which enables one to locate *at once* the data required.
For any information—any specimen—any volume on free examination

Apply immediately to

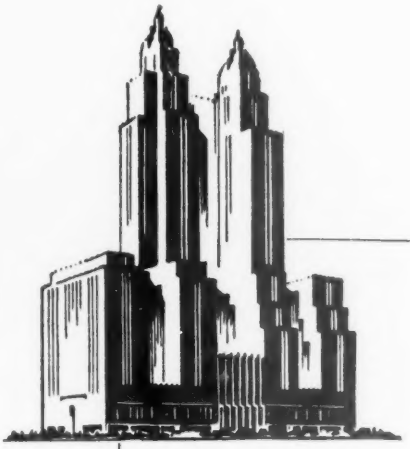
Canada and U.S.A.
The McGraw-Hill Book Company, Inc.
370 Seventh Avenue
New York, N. Y.

Other Countries
M. C. MARIE
9, rue de Bagneux
Paris VI° France

Volumes published: 1st Series—I to V—1910–1922 (5382 pages) and index (382 pages)
2nd " VI to IX—1923–1929 (7884 pages) and Index to Vol. IX (124 pages)

Specimens: Reprints of the following sections are sent free of charge: Spectroscopy—Electricity, Magnetism, and Electrochemistry—Radioactivity—Crystallography and Mineralogy—Biology—Engineering and Metallurgy — Colloids — Wireless — Photography — Geophysics — Combustible Gaseous Mixtures, Powders, and Explosives.

English versions: Beginning with Volume VII, all explanations to the tables are given both in English and French.



NEW YORK HOLIDAY

at The Waldorf

Really enjoy yourself, on your next visit, by staying at The Waldorf-Astoria . . . convenient to theatres, shops, terminals . . . crosstown buses at the door every three minutes . . . a taxi terminal within the hotel itself. Never a moment wasted with The Waldorf as your headquarters.

Waldorf restaurants offer a variety of menus including popular price meals. Waldorf rooms have every modern appointment . . . world-wide radio . . . all-night room service.

THE

WALDORF-ASTORIA

Park Avenue • 49th to 50th • New York

ALPHABETICAL LIST OF ADVERTISERS

	Page
Allied Engineering Company	18
American Potash & Chemical Corporation	18
Bausch & Lomb Optical Co.	21
Bethlehem Steel Company	22
Buyers' Guide	7–10
Carborundum Co.	16
Celo Mines, Inc.	166
Ceramic Color & Chemical Mfg. Company	6
Chicago Vitreous Enamel Product Company	22
Classified Advertising	10
Corhart Refractories Company	12
Denver Fire Clay Co.	22
Du Pont de Nemours, E. I. & Company	15
Edgar Brothers Company	2
Edgar Plastic Kaolin Company	2
Electro Refractories & Alloys Corporation	19
Edward Orton, Jr., Ceramic Foundation	21
Frazier-Simplex, Inc.	13
Hammill & Gillespie, Inc.	18
Harris Clay Co.	20
Hartford-Empire Company	20
Hommel, O., Company, Inc.	17
Journal Society of Glass Technology	6
Lancaster Iron Works, Inc.	Inside Front Cover
McDanel Refractory Porcelain Company	18
Metal & Thermit Corporation	Outside Back Cover
Montgomery Porcelain Products Company	17
Norton Co.	5
Orton, Edward, Jr., Ceramic Foundation	21
Pacific Coast Borax Company	11
Paper Makers Importing Company	14
Pittsburgh Plate Glass Company	6
Porcelain Enamel & Mfg. Company	14
Potters Supply Company	17
Professional Directory	11
Proctor & Schwartz, Inc.	11
Pyrometer Instrument Co.	4
Sant, Richard, Co.	20
Solvay Sales Corporation	14
Spinks, H. C., Clay Company	Inside Back Cover
Tables Annuelles de Constantes	2
Vitro Mfg. Company	4
Waldorf-Astoria	3
Willson Products, Inc.	10
Wilson, H. W., Company	11

THE VITRO MFG. CO. TRADE MARK PITTSBURG, PA.

Discriminating users of ceramic colors will ally themselves with a progressive source of supply.

Vitro offers the advantages of intelligently directed research and a highly efficient organization.

VITRO

CORLISS STATION — PITTSBURGH, PA.

16 California St. San Francisco, Cal.

PYRO THE SIMPLIFIED OPTICAL PYROMETER

THE ONLY SELF-CONTAINED, DIRECT READING, RUGGED and FOOL-PROOF INSTRUMENT FOR GLASS AND CERAMIC PLANTS, LABORATORIES, Etc.

Unique construction enables operator to rapidly determine temperature even on minute spots, fast moving objects or the smallest streams; no correction charts to consult, no accessories, no upkeep.

New concentrated test mark and ease of operation permit unusually close and rapid temperature determinations. Its advanced features place PYRO in a class by itself; it is standard equipment with the leading plants in your industry.

Stock Ranges 1400° to 5500°F.

PYRO RADIATION PYROMETER

The ideal instrument for Furnace or Kiln use. Gives actual heat of material aside

from furnace or kiln temperature. Does not require a skilled operator—strictly automatic. Eliminates personal errors. Always ready to tell within a few seconds any shortcomings in your equipment. Stock Ranges 1000° to 3600°F.

Write for special bulletins.

THE PYROMETER INSTRUMENT CO.

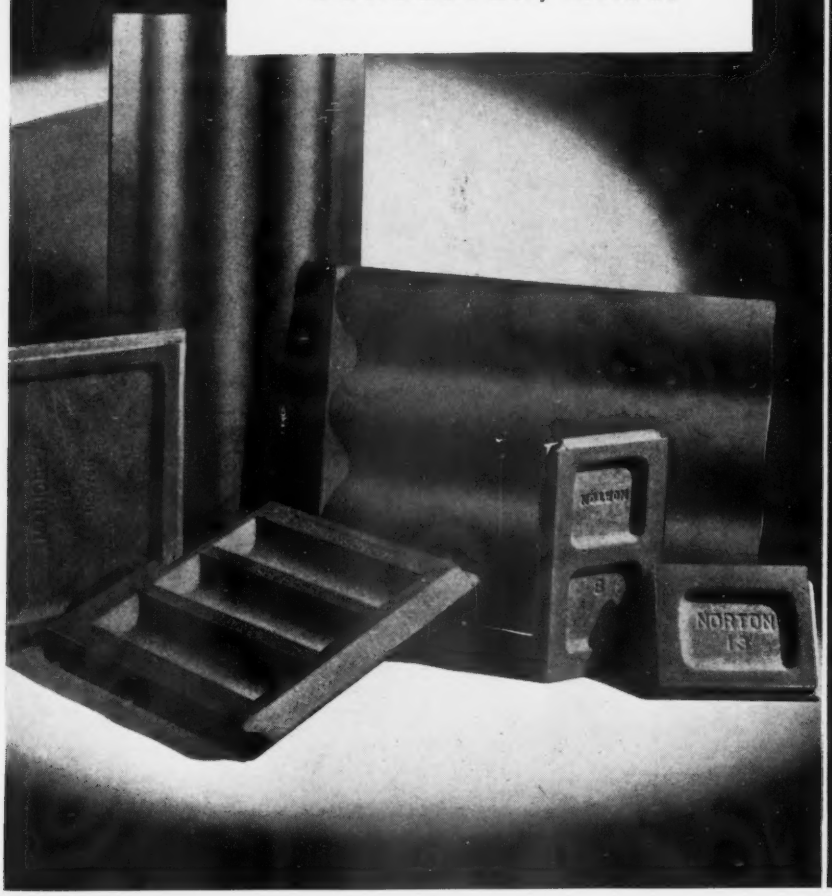
105-109 Lafayette St. New York, N. Y.

For Lower REFRACTORY COSTS . . .

ALUNDUM PLATES
Plain and Corrugated

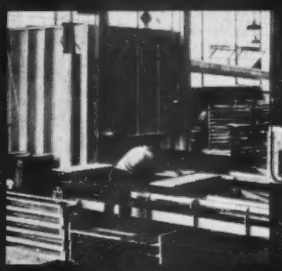
CHEMICAL stability and high refractoriness are outstanding qualities found in Alundum Plates for ceramic kilns and furnaces. Norton Company, long experienced in the manufacture and burning of ceramic products, has developed Alundum Refractories to their present state of high quality and efficiency from a complete knowledge of high temperature requirements.

NORTON COMPANY
WORCESTER, MASS.



SPECIAL REFRACTORIES for

. . . Tunnel Kilns and Periodic



. . . Box-Type Enameling Furnaces

. . . Continuous Enameling Furnaces

Norton Engineers will be glad to study your kiln or furnace problems and recommend the most suitable refractories.

NORTON REFRACTORIES

R-553

For Satisfaction in Production

"CERAMIC"

COLORS

FOR ENAMELS:—Colors and Oxides; Smelter Oxides; Graining, Printing, Banding, and Screening Colors.
FOR POTTERY:—Glaze and Body Stains; Underglaze and Overglaze Colors for Banding, Spraying, and Screening; Fritted Glazes and Fluxes.
FOR GLASS:—Enamels; Vitrifiable Colors for Banding, Spraying, and Screening; Printing Colors; Fluxes; Batch Colors.
DECORATING SUPPLIES:—Printing Tissue; Screening Oils, French Fat Oil, Oil of Copaiba, Balsam Fir, Damar Varnish; Brushes; Knives and Spatulas; Grinding Mills.

CHEMICALS

Aluminum Hydrate
Ammonium Carbonate
Antimony Oxide
Antimony, Black Needle
Barium Carbonate
Barium Chromate
Bone Ash
Cadmium Carbonate
Cadmium Oxide
Cadmium Sulphide
Calcspar
Chrome Oxide, Green
Clay, Vallendar
Cobalt Oxide, Black
Cobalt Sulphate
Copper Oxides
Iron Chromate
Iron Oxides
Kryolith
Lead Chromate
Magnesium Carbonate
Manganese Dioxide
Nickel Oxide, Black
Nickel Oxide, Gray
Nickel Sulphate
Potassium Bichromate
Potassium Nitrate
Potassium Permanganate
Powder Blue
Rutile, Powdered
Selenium
Sodium Aluminate
Sodium Antimonate
Sodium Bichromate
Sodium Silicate
Sodium Silico Fluoride
Sodium Uranate
Tin Oxide
Titanium Oxide
Uranium Oxide, Orange
Uranium Oxide, Yellow
Zirconium Oxide

"CERAMIC" COLORS

CERAMIC COLOR & CHEMICAL MFG. CO., NEW BRIGHTON, PENNA.

International Congress on Glass

(London and Sheffield, 1936)

The August, 1936, number of the "Journal of the Society of Glass Technology" contains a complete account of the Proceedings of the Congress and the first batch of ten valuable papers by authorities of international repute.

The October, 1936, number contains 27 other papers presented at the Congress.

Copies, price 10/–d. ($2.46) each, may be obtained from the Secretary, or from the American Ceramic Society.

The Society of Glass Technology, Darnall Road, Sheffield 9, England

● WE MAKE

Glass House Refractories

Flux Blocks
Pots Open & Covered
Refractory Blocks
Highlands Pot Clays
Prepared Mixes
Special Batches

P. B. Sillimanite

Standard Sizes and Shapes to Order

● WE SELL

● WE USE OUR OWN

PITTSBURGH PLATE GLASS COMPANY
Refractories Division
GRANT BUILDING, PITTSBURGH, PA.

Abrasives
Carborundum Co. (*Carborundum and Aloxite*)
Chicago Vitreous Enamel Products Co.
The Hommel Co., O., Inc.
Norton Co. (*Alundum-Crystolon*)

Air Conditioning Systems
Simplex Engineering Co.

Aloxite (Refractory Products)
Carborundum Co.

Alumina (Hydrate and Calcined)
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Alumina (Fused) Brick and Tile
Electro Refractories & Alloys Corp.
The Vitro Mfg. Co.

Aluminum Oxide (Calcine)
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Aluminum Oxide (Fused)
Carborundum Co.
Electro Refractories & Alloys Corp.
Norton Co.
The Vitro Mfg. Co.

Alundum (Refractory Products)
Norton Co.

Ammonium Bicarbonate
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Solvay Sales Corp.

Ammonium Bifluoride
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Ammonium Carbonate
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Antimony Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Arches (Interlocking, Suspending, and Circular)
Simplex Engineering Co.

Automatic Brick Car Loaders
Lancaster Iron Works, Inc.

Ball Mills
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Hardinge Company, Inc.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co.
McDanel Refractory Porcelain Co.
The Vitro Mfg. Co.

Ball Mills (Laboratory Type)
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Denver Fire Clay Co.
Hardinge Company, Inc.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co.
The Vitro Mfg. Co.

Barium Carbonate
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Barytes
The Seaboard Feldspar Co.

Batch Systems
Lancaster Iron Works, Inc.
Simplex Engineering Co.

Batts
Carborundum Co. ("*Carbofrax Aloxite*")
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
Norton Co. (*Alundum-Crystolon*)

Bitstone
Consolidated Feldspar Corp.
Potters Supply Co.

Body Stains
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.

Blocks (Refractory)
Carborundum Co.
Chicago Vitreous Enamel Product Co.
Corhart Refractories Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
Norton Co.
Pittsburgh Plate Glass Co.
The Vitro Mfg. Co.

Borax
American Potash & Chemical Co.
Denver Fire Clay Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Pacific Coast Borax Co.
The Vitro Mfg. Co.

Borax Glass
American Potash and Chemical Corp.
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Pacific Coast Borax Co.
The Vitro Mfg. Co.

Boric Acid (Anhydrous)
Denver Fire Clay Co.
Drakenfeld & Co., B. F.
The Hommel Co., O., Inc.
Pacific Coast Borax Co.
The Vitro Mfg. Co.

Boric Acid (Crystal, Granular, or Powder)
American Potash & Chemical Corp.
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
Drakenfeld & Co., B. F.
The Hommel Co., O., Inc.
Pacific Coast Borax Co.
The Vitro Mfg. Co.

Boron Carbide
Norton Co.

Brick Machines (also Barrows, Molds)
Lancaster Iron Works, Inc.

Brick (Refractory)
Carborundum Co. ("*Carbofrax Aloxite*")
Chicago Vitreous Enamel Product Co.
Corhart Refractories Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
Norton Co.
The Vitro Mfg. Co.

Carbofrax (Refractory Products)
Carborundum Co.

Carbonates (Barium, Lead)
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Castings
Lancaster Iron Works, Inc.

Castings (Abrasive Resisting)
Bethlehem Steel Co.

Caustic Potash
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Solvay Sales Corp.

Caustic Soda
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Pittsburgh Plate Glass Co.
Solvay Sales Corp.
The Vitro Mfg. Co.

Cements
Carborundum Co.
Chicago Vitreous Enamel Product Co.
Corhart Refractories Co.
Electro Refractories & Alloys Corp.
Norton Co.
Pittsburgh Plate Glass Co.

Ceramic Chemicals
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
The Porcelain Enamel and Mfg. Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Chromium Oxide
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Clay (Ball)
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
Kentucky Clay Mining Co.
Kentucky-Tennessee Clay Co.
Paper Makers Importing Co.
Potters Supply Co.
Spinks Clay Co., H. C.
The Vitro Mfg. Co.
United Clay Mines Corp.

Clay (Block)
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.

Clay (China)
Ceramic Color & Chemical Mfg. Co.
Consolidated Feldspar Corp.
Edgar Brothers Co.
Edgar Plastic Kaolin Co.
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
Kentucky Clay Mining Co.
Paper Makers Importing Co.
Sant, Richard C.
The Vitro Mfg. Co.
United Clay Mines Corp.

Clay—Cleaners, Feeders
Lancaster Iron Works, Inc.

Clay (Electrical, Porcelain)
Ceramic Color & Chemical Mfg. Co.
Edgar Brothers Co.
Edgar Plastic Kaolin Co.
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
Kentucky Clay Mining Co.
Kentucky-Tennessee Clay Co.
Paper Makers Importing Co.
Spinks Clay Co., H. C.
United Clay Mines Corp.

Clay (Enamel)
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Edgar Brothers Co.
Edgar Plastic Kaolin Co.
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co.
Kentucky Clay Mining Co.
Kentucky-Tennessee Clay Co.
Metal & Thermit Corp.
Paper Makers Importing Co.
The Porcelain Enamel & Mfg. Co.
Spinks Clay Co., H. C.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.
United Clay Mines Corp.

Clay (Fire)
Denver Fire Clay Co.
Edgar Brothers Co.
Edgar Plastic Kaolin Co.
Kentucky Clay Mining Co.
Kentucky-Tennessee Clay Co.
Paper Makers Importing Co.
Pittsburgh Plate Glass Co.
Potters Supply Co.

Clay (German Vallendar)
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co.
Kentucky Clay Mining Co.
Jungmann & Co.
The Porcelain Enamel & Mfg. Co.
The Vitro Mfg. Co.
United Clay Mines Corp.

Clay Miners
Edgar Brothers Co.
Edgar Plastic Kaolin Co.
Kentucky Clay Mining Co.
Kentucky-Tennessee Clay Co.
Paper Makers Importing Co.
Spinks Clay Co., H. C.
United Clay Mines Corp.

Clay (Potters)
Denver Fire Clay Co.
Edgar Brothers Co.
Edgar Plastic Kaolin Co.
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
Kentucky Clay Mining Co.
Paper Makers Importing Co.
Sant, Richard C.
Spinks Clay Co., H. C.
United Clay Mines Corp.

Clay (Process Equipment)
Hardinge Company, Inc.
Lancaster Iron Works, Inc.

Clay (Sagger)
Edgar Brothers Co.
Edgar Plastic Kaolin Co.
The Hommel Co., O., Inc.
Kentucky Clay Mining Co.
Kentucky-Tennessee Clay Co.
Paper Makers Importing Co.
Pittsburgh Plate Glass Co.
Potters Supply Co.
Spinks Clay Co., H. C.
United Clay Mines Corp.

Clay (Wad)
Kentucky Clay Mining Co.
Kentucky-Tennessee Clay Co.
Potters Supply Co.
Spinks Clay Co., H. C.
United Clay Mines Corp.

Clay (Wall Tile)
Edgar Brothers Co.
Edgar Plastic Kaolin Co.
Hammill & Gillespie, Inc.
Kentucky Clay Mining Co.
Kentucky-Tennessee Clay Co.
Paper Makers Importing Co.
Sant, Richard C.
Spinks Clay Co., H. C.
United Clay Mines Corp.

Cleaners
The Porcelain Enamel and Mfg. Co.

Clocks (Gauge Board)
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.

Cobalt Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co.
The Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

Colors
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co.
Pittsburgh Plate Glass Co.
The Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

Cones
The Edward Orton, Jr., Ceramic Foundation

Conveying Equipment
Lancaster Iron Works, Inc.
Simplex Engineering Co.

Corhart
Corhart Refractories Co.

Cornwall Stone (Imported)
Consolidated Feldspar Corp.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
Paper Makers Importing Co.

Crucibles (Filter, Melting, Ignition)
Carborundum Co.
Denver Fire Clay Co.
Norton Co.
Pittsburgh Plate Glass Co.
Potters Supply Co.

Crushers (Clay)
Lancaster Iron Works, Inc.

Crystolon (Refractory Products)
Norton Co.

Cullet, Washing Plants, Incinerators, Crushers
Simplex Engineering Co.

Decorating Supplies
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Pittsburgh Plate Glass Co.
The Vitro Mfg. Co.

Disintegrators
Hardinge Company, Inc.
Lancaster Iron Works, Inc.

Dryer (Pipe Rack)
Lancaster Iron Works, Inc.

Drying Machinery
Lancaster Iron Works, Inc.
Proctor & Schwartz, Inc.
Simplex Engineering Co.

Electrocast Refractories
Corhart Refractories Co.

Enameling Equipment (Complete)
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co.
Simplex Engineering Co.
The Vitro Mfg. Co.

Enameling Furnaces
Carborundum Co.
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Electro Refractories & Alloys Corp.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co.
Lancaster Iron Works, Inc.
Norton Co.

Enameling Iron (Sheet)
American Rolling Mill Co.
Bethlehem Steel Co.

Enameling Muffles
Bethlehem Steel Co.
Carborundum Co. (*Carbofrax*)
Chicago Vitreous Enamel Product Co.
Electro Refractories & Alloys Corp.
Norton Co. (*Alundum*)
Pittsburgh Plate Glass Co.
Simplex Engineering Co.

Enameling (Practical Service)
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co.
Metal & Thermit Corp.
The Porcelain Enamel & Mfg. Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Enamels
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Pittsburgh Plate Glass Co.
The Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

Enamel Oxide
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.

Enamels (Porcelain)
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co.
The Porcelain Enamel & Mfg. Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Equipment (Porcelain Enameling)
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
The DeVilbiss Co.
Hardinge Company, Inc.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co.

Exhaust Systems
The DeVilbiss Co.

Feldspar
Ceramic Color & Chemical Mfg. Co.
Consolidated Feldspar Corp.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Paper Makers Importing Co.
The Porcelain Enamel and Mfg. Co.
Sant, Richard C.
The Seaboard Feldspar Co.
The Vitro Mfg. Co.

Fire Brick
Carborundum Co.
Corhart Refractories Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
Norton Co.

Fire Brick—Process Equipment
Lancaster Iron Works, Inc.

Fire Clay
Kentucky Clay Mining Co.
Spinks Clay Co., H. C.

Flint
Ceramic Color & Chemical Mfg. Co.
Consolidated Feldspar Corp.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Paper Makers Importing Co.
The Porcelain Enamel and Mfg. Co.

Flint Pebbles
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Consolidated Feldspar Corp.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co.
The Vitro Mfg. Co.

Floors (Non-Slip)
Norton Co.

French Flint
Consolidated Feldspar Corp.
Paper Makers Importing Co.

Frit
Allied Engineering Co.
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co.
Porcelain Enamel & Mfg. Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Fuel Oil Systems and Control, Stokers
Bethlehem Steel Co.
Simplex Engineering Co.

Furnaces
Allied Engineering Co.
Carborundum Co. (*Carboradiant*)
Chicago Vitreous Enamel Product Co.
Denver Fire Clay Co.
The Hommel Co., O., Inc.
Simplex Engineering Co.

Glass Bending Ovens, Glass Decorating Machines
Simplex Engineering Co.

Glass Equipment
Hartford-Empire Co.
Lancaster Iron Works, Inc.

Glass Melting Pots (Open and Covered)
Pittsburgh Plate Glass Co.

Glass Melting Tanks and Furnaces
Pittsburgh Plate Glass Co.
Simplex Engineering Co.

Glass Thickness Gauge
Bausch & Lomb Optical Co.

Glaze and Body Spar
Ceramic Color & Chemical Mfg. Co.
Consolidated Feldspar Corp.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Paper Makers Importing Co.
The Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

Glazes and Enamels
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. H. Chemicals Dept.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
The Porcelain Enamel & Mfg. Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Glaze Spar
Ceramic Color & Chemical Mfg. Co.
Consolidated Feldspar Corp.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Paper Makers Importing Co.

Goggles
Willson Products, Inc.

Gold
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. H. & Chemicals Dept.
The Hommel Co., O., Inc.
The Vitro Mfg. Dept.

Gold Decorations
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Co.

Granulators
Hardinge Company, Inc.
Lancaster Iron Works, Inc.

Grinding Wheels
Carborundum Co. (*Carborundum and Aloxite*)
Chicago Vitreous Enamel Product Co.
Norton Co. (*Alundum-Crystolon*)

Hearths
Carborundum Co. (*Carbofrax* heat treating)
Corhart Refractories Co.
Electro Refractories & Alloys Corp.
Norton Co. (*Crystolon*)

Hearths (Fused Al_2O_3, SiC)
Electro Refractories & Alloys Corp.

Hearths (High Aluminous Clay, Electrically Sintered Aluminum Oxide, Silicon Carbide)
Carborundum Co.

Norton Co.

Hose (Air and Fluid)
The DeVilbiss Co.

Iron (Enameling)
American Rolling Mill Co.
Bethlehem Steel Co.

Iron Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
The Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

Kaolin
Ceramic Color & Chemical Mfg. Co.
Consolidated Feldspar Corp.
Edgar Brothers Co.
Edgar Plastic Kaolin Co.
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
Paper Makers Importing Co.
Sant, Richard C.
United Clay Mines Corp.
The Vitro Mfg. Co.

Kellog AA Refractories
Electro Refractories & Alloys Corp.

Kilns, China (Decorating)
Allied Engineering Co.
Denver Fire Clay Co.
Drakenfeld & Co., B. F.
The Hommel Co., O., Inc.
Simplex Engineering Co.

Kiln Furniture (Silicon Carbide, Semi-Silicon Carbide)
Electro Refractories & Alloys Corp.

Kyanite
Celo Mines, Inc.

Kryolith
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Jungmann & Co.
The Vitro Mfg. Co.

Laboratory Ware
Norton Co.

Lehr Tile (High Aluminous Clay, Electrically Sintered Aluminum Oxide, Silicon Carbide)
Carborundum Co.
Electro Refractories & Alloys Corp.

Lehrs
Simplex Engineering Co.

Lehrs (Electric or Fuel Heated)
Simplex Engineering Co.

Lehr Loaders
Simplex Engineering Co.

Linings (Furnace Refractory, Block Refractory Plate, Brick and Tile)
Carborundum Co.
Chicago Vitreous Enamel Product Co.
Corhart Refractories Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
Jungmann & Co.
Norton Co.
Pittsburgh Plate Glass Co.
The Vitro Mfg. Co.

Magnesia (Fused)
Electro Refractories & Alloys Corp.

Magnesia (Sintered, Calcined)
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Norton Co.
The Porcelain Enamel and Mfg. Co.

Magnesite
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Manganese
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Manganese (Oxide)
Ceramic Color & Chemical Mfg. Co.
Corhart Refractories Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.

Masks (Breathing)
The DeVilbiss Co.
Willson Products, Inc.

Metals (Porcelain Enameling)
American Rolling Mill Co.
Bethlehem Steel Co.

Microscopes (Polarizing)
Bausch & Lomb Optical Co.

Minerals
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Mixers (Batch)
Lancaster Iron Works, Inc.

Mold Sanders
Lancaster Iron Works, Inc.

Muffles (Furnace)
Allied Engineering Co.
Carborundum Co. (*Carbofrax*)
Chicago Vitreous Enamel Product Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
Norton Co.
Pittsburgh Plate Glass Co.
Simplex Engineering Co.

Muffles (Laboratory)
Electro Refractories & Alloys Corp.

Mullite (Refractories)
Electro Refractories & Alloys Corp.

Muriatic Acid
Denver Fire Clay Co.
The Hommel Co., O., Inc.

Nitrates (Cobalt, Sodium)
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Non-Gro Refractories
Electro Refractories & Alloys Corp.

Norbide (Norton Boron Carbide)
Norton Co.

Olivine
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.

Opacifiers
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Metal & Thermit Corp.
The Porcelain Enamel & Mfg. Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Overglaze Colors
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.

Oxides
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Metal & Thermit Corp.
Porcelain Enamel & Mfg. Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Palladium Decorations
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.

Pins
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Potters Supply Co.

Platinum Decorations
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.

Polariscopes
Bausch & Lomb Optical Co.
Simplex Engineering Co.

Porcelain Enameling Service (Practical)
American Rolling Mill Co.
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Hardinge Company, Inc.
The Hommel Co., O., Inc.
Jungmann & Co.
The Porcelain Enamel & Mfg. Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Porcelain Enamels
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
The Porcelain Enamel & Mfg. Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Potash (Carbonate)
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Solvay Sales Corp.
The Vitro Mfg. Co.

Producer Glass Plants
Simplex Engineering Co.

Pug Mills
Lancaster Iron Works, Inc.

Pyrophyllite
The Seaboard Feldspar Co.

Pyrometer Tubes
Carborundum Co.
Electro Refractories & Alloys Corp.
Montgomery Porcelain Products Co.

Pyrometer Tubes (Refractory and Hard Porcelain)
Denver Fire Clay Co.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.
Norton Co.

Pyrometers (Optical, Radiation, Surface, Immersion, Needle)
Pyrometer Instrument Co.

Pyrometric Cones
The Edward Orton, Jr., Ceramic Foundation

Raw Material Handling Equipment
Simplex Engineering Co.
Lancaster Iron Works, Inc.

Refractometers
Bausch & Lomb Optical Co.

Refractories
Carborundum Co.
Corhart Refractories Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
Kentucky-Tennessee Clay Co.
New Castle Refractories Co.
Norton Co.
Pittsburgh Plate Glass Co.

Refractory Materials
Carborundum Co.
Chicago Vitreous Enamel Product Co.
Corhart Refractories Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
Kentucky-Tennessee Clay Co.
Norton Co.
Pittsburgh Plate Glass Co.
Sant, Richard C.
Titanium Alloy Mfg. Co.

Represses (Automatic)
Lancaster Iron Works, Inc.

Respirators
Chicago Vitreous Enamel Product Co.
The DeVilbiss Co.
The Hommel Co., O., Inc.
Willson Products, Inc.

Rutile
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc. R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Saggers
Carborundum Co.
Electro Refractories & Alloys Corp.
Norton Co.
Potters Supply Co.

Salt Cake
American Potash & Chemical Co.
The Hommel Co., O., Inc.

Sandblast Helmets
Willson Products, Inc.

Sand Grinder and Sifters
Lancaster Iron Works, Inc.

Saponin
The Hommel Co., O., Inc.

Selenite of Sodium
Drakenfeld & Co., B. F.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Selenium
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.

The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Sheets (Enameling Iron)
American Rolling Mill Co.
Bethlehem Steel Co.

Silica (Fused)
Electro Refractories & Alloys Corp.
The Hommel Co., O., Inc.

Silicate of Soda
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
The Hommel Co., O., Inc.

Silicon Carbide
Carborundum Co.
Electro Refractories & Alloys Corp.
Norton Co.

Silicon Carbide Firesand
Carborundum Co.

Sillimanite Refractories
Electro Refractories & Alloys Corp.

Sillimanite (Synthetic)
Pittsburgh Plate Glass Co.

Slabs (Furnace)
Carborundum Co.
Electro Refractories & Alloys Corp.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Norton Co.
Pittsburgh Plate Glass Co.

Soda Ash
American Potash and Chemical Corp.
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Pittsburgh Plate Glass Co.
Solvay Sales Corp.
The Vitro Mfg. Co.

Sodium Antimonate
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
The Vitro Mfg. Co.

Sodium Fluoride
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Jungmann & Co.
The Vitro Mfg. Co.

Sodium Silica Fluoride
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.

Soot Blowers
Simplex Engineering Co.

Special Machines
Simplex Engineering Co.

Spar
Ceramic Color & Chemical Mfg. Co.
Consolidated Feldspar Corp.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Paper Makers Importing Co.
The Vitro Mfg. Co.

Spray Booths
The DeVilbiss Co.

Spraying Equipment
The DeVilbiss Co.

Spurs
Potters Supply Co.

Stacks
Lancaster Iron Works, Inc.

Steel Plate Construction
Bethlehem Steel Co.
Lancaster Iron Works, Inc.

Stilts
Potters Supply Co.

Sulfuric Acid
Denver Fire Clay Co.
The Hommel Co., O., Inc.

Talc
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
Paper Makers Importing Co.

Tanks
Simplex Engineering Co.

Tank Blocks
Corhart Refractories Co.
Pittsburgh Plate Glass Co.

Tanks (Pickle)
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.

Tanks for Raw Material Steel or Concrete
Bethlehem Steel Co.
Lancaster Iron Works, Inc.

Tile (Floor)
Norton Co.

Tile (Muffle)
Carborundum Co.
Electro Refractories & Alloys Corp.
Norton Co.

Tile (Refractory)
Carborundum Co. (*Carbofrax*)
Chicago Vitreous Enamel Product Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
Norton Co.
Pittsburgh Plate Glass Co.

Tile (Wall)
Denver Fire Clay Co.

Tin Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
The Vitro Mfg. Co.

Titanium
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Hommel Co., O., Inc.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Titanium Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Trucks
Lancaster Iron Works, Inc.

Tubes (Insulating)
Carborundum Co.
McDanel Refractory Porcelain Co.
Norton Co.

Tubes (Pyrometer)
Carborundum Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.
Norton Co.
Pittsburgh Plate Glass Co.

Uronium Oxide (Yellow-Orange-Black)
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Vitro Mfg. Co.

Water Softening Plants
Simplex Engineering Co.

Wet Enamel
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co.
The Porcelain Enamel & Mfg. Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Whiting
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
Paper Makers Importing Co.
The Vitro Mfg. Co.

Winding Drums
Lancaster Iron Works, Inc.

Zinc Oxide
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Zirconia
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

WILLSON BAG RESPIRATORS

Nos. 300 and 400 (Patent applied for) have
UNITED STATES BUREAU OF MINES APPROVALS
A Willson style for every dusty operation in the Ceramic Industry.
WILLSON PRODUCTS, Inc. **Reading, Pa.**

WANTED—Clay Sales Engineer. Preferences, age twenty-five years, technical training, table ware experience, trade acquaintance. A real opportunity. Give personal and business details fully. Address—The American Ceramic Society, Box 150F, 2525 N. High St., Columbus, Ohio.

BORAX *Guaranteed 99½%–100% Pure* **BORIC ACID**

Select the Brand which has back of it years of *successful use* by experienced Ceramists

Pacific Coast Borax Co., New York

Chicago **Los Angeles**

BACK NUMBERS
OF
JOURNAL OF AMERICAN CERAMIC SOCIETY
AND ALL IMPORTANT MAGAZINES FROM THE WORLD OVER

We furnish single copies, volumes and sets or photostat reproductions of specific sections, reasonably and promptly

WRITE, PHONE OR WIRE PERIODICALS DEPARTMENT

THE H. W. WILSON COMPANY 950 University Avenue, New York

COMMERCIAL TESTING ● RESEARCH ● ANALYSES

BAILEY & SHARP CO., INC.

CHEMISTS, CONSULTING ENGINEERS, GLASS TECHNOLOGISTS

SPECIALIZING IN TESTING, RESEARCH AND DEVELOPMENT WORK IN ENGINEERING AND CHEMICAL PROCESSES CONNECTED WITH THE MANUFACTURE AND USE OF CERAMIC PRODUCTS.

HAMBURG, N. Y. U. S. A.

EMERSON P. POSTE

CONSULTING CHEMICAL ENGINEER

ANALYSES: CERAMIC RAW MATERIALS AND PRODUCTS, FUELS, IRON AND STEEL, ETC.

SPECIAL INVESTIGATIONS: PHYSICAL AND CHEMICAL TESTS ON ENAMEL, ETC.

309 McCALLIE AVE.,
CHATTANOOGA, TENN.

THE SHARP-SCHURTZ COMPANY

CHEMISTS FOR THE CERAMIC INDUSTRY

WE HAVE FULLY EQUIPPED LABORATORIES AT

LANCASTER, OHIO U. S. A.

Tunnel, Truck and Humidity Dryers
for—
Dry Pressed Electrical Porcelain
High Voltage Electrical Porcelain
Sanitary Porcelain
Floor and Wall Tile
Abrasive Wheels
Glass Pots and Blocks
Refractory Brick and Shape
Also Stove Rooms and Mangles for General Dinnerware

PROCTOR & SCHWARTZ, INC.
The Largest Builders of Drying Machinery for Industry
Seventh Street & Tabor Road, Philadelphia, Pa.

FUEL CONSUMPTION DATA

For a Large Continuous Tank

On Two Consecutive Runs*

	TOTAL DAYS LIFE	TOTAL PRODUCING DAYS	TOTAL GLASS DELIVERED (TONS)	TOTAL GAS CONSUMED (M)	USEFUL GAS (M) 3000 × GLASS PRODUCED	TOTAL WASTE GAS (M)	WASTE GAS PER DAY (M)	TOTAL WASTE GAS FOR TOTAL IDLE DAYS	TOTAL GAS CONSUMED ON OPERATING DAYS	CU. FT. GAS PER TON GLASS
LAST RUN ——→	577	447	46,326	417,978	138,978	279,000	484	62,920	355,058	7664
PRESENT RUN*→	459	368	46,173	364,815	138,519	226,296	493	44,863	319,952	6929

*The figures quoted for the second run are for the first 459 days only. A total life of at least 700 days is expected from this tank.

UP GOES PRODUCTION--
DOWN GOES FUEL COST!

SEVERAL months ago we published the fuel-performance record of a large continuous bridgewall-type tank exactly as shown in the first line of the "blueprint" above. In the construction of that furnace 57.25 tons of Corhart Electrocast were used.

In June of 1935 this furnace was repaired in identical design, *but this time the use of Corhart was so far extended as to utilize 87 tons.* This represents an increase of 29.75 tons or 52% in the present campaign. . . . The second line in the tabulation shows the fuel performance of the current run, at the end of its first 459 days. Please note the following salient facts:

(1) The total fuel consumed per ton of glass produced has been reduced 12.2%.

(2) The glass delivered in the 459 days of the present campaign is virtually equal to that delivered in the 577 days of the previous campaign.

(3) Please note that in the column headed "Waste Gas Per day" (sometimes called "fuel to hold temperature") *the figure is somewhat higher for the present run than for the relatively less efficient former run.* Since some operators use "fuel to hold temperature" as a measuring stick for tank efficiency, we again point out the grave errors that can be made by such an assumption.

(4) In the last analysis, the fuel efficiency of a furnace is determined by the fuel cost per ton of glass produced, and by this measuring stick the efficiency of this furnace has been measurably increased during the present fire.

(5) The lower fuel cost per ton of glass produced has been realized simultaneously with a 52% increase in the amount of Corhart used.

(6) The statistics again prove that

The fuel efficiency of a glass furnace is a matter of engineering, design and operation. It is not a function of the particular materials of which its sidewalls are constructed.

QUALITY ECONOMY ENDURANCE

CORHART ELECTROCAST REFRACTORIES

Corhart Refractories Co., *Incorporated*, 16th and Lee Sts., Louisville, Kentucky. *In Europe:* L'Electro Refractaire, Paris. *In Japan:* Asahi Glass Co., Tokio.

THE BULLETIN
OF THE AMERICAN CERAMIC SOCIETY

A Monthly Publication Devoted to Proceedings of the Society and Promotion of Coöperative Research of Technical, Scientific, and Art Questions

VOLUME 16 APRIL, 1937 NUMBER 4

PAPERS

BRICK MASONRY IN STATE HIGHWAY BRIDGES IN OHIO*

By J. C. Merrell

Abstract

A review is given of the brick structures of the past and an outline of the uses of brick in the structures of the present day, including a discussion of brick-lined structures for acid-carrying streams as well as the reinforced-brick masonry structures already built or under construction. Some of the more technical problems involved in the design of these structures are presented, such as the reason why the entire structure is not of reinforced-brick masonry, the selection of unit stresses to be used in design, selection of the type of brick and mortar, methods of waterproofing, methods of flashing, particular specifications required, alternate types of brick to be permitted, and some of the difficulties encountered in adapting brick masonry to our structures.

I. Introduction

Brick masonry has been seldom used in the past for bridge building because it was a form of construction adaptable mainly to compression stresses, whereas almost all parts of a bridge structure must also be capable of taking bending stresses and sometimes tension stresses. It is true that stone masonry was used in gravity-type bridge substructures for a great many years, but this type of substructure has been replaced almost entirely by the lighter, reinforced type in which the thickness is greatly reduced and the stresses are taken in bending on reinforced masonry. With the development of reinforced brick masonry a new type of construction was made available for highway bridges.

(1) Unreinforced Brick Culvert in 1912

The State Highway Department of Ohio designed several unreinforced brick arch culverts which were built in 1912, varying in size up to about a 12-foot span. These structures were in Vinton County on State Route 75 between McArthur and a point about $6^1/_2$ miles south of McArthur. Some of them were replaced in 1934 by the Bureau of Construction during the rebuilding of the highway, but these replacements were made because of foundation failures, the brick masonry itself being still in good condition after twenty-two years of service.

(2) Brick Resists Sulfuric Acid from Coal Mines

Coal mining is an important industry in eastern Ohio, and the water which flows both from the operating and the abandoned mines has a high content of sulfuric acid. During dry periods the acid content of some of our small streams becomes very high and destructive to structures. Brick masonry or brick lining with an asphaltic filler has been found to be an excellent material to resist this acid, and several structures have been built using asphalt-filled brick as a facing or lining material where this acid has been particularly

* Presented at the Annual Meeting, American Ceramic Society, Columbus, Ohio, April 1, 1936 (Structural Clay Products Division).

destructive. Placing brick linings on existing concrete culverts has not been successful because of the tendency of the acids to get behind the brickwork and disintegrate the concrete, leaving the brickwork unsupported and useless as a protection. On new structures, however, where the brickwork can be built monolithic with the concrete, it has been successful. Brick facing was used as a protection for the substructure of one large bridge, but this has since been replaced by another structure owing to a relocation of the highway, and records do not show whether or not this was satisfactory.

FIG. 1.—Bridge on State Route 39 at Sugar Creek, Tuscarawas County, Ohio.

(3) State Highway Reinforced Brick Bridge in 1934

The first State Highway bridge in Ohio in which reinforced brick masonry was used was built in 1934 in Tuscarawas County on State Route 39 at the village of Sugar Creek over the South Fork of Sugar Creek. Another bridge of similar type has been designed to carry the Lincoln Highway (U. S. Route 30) over Hugle Run in Stark County. This structure will be 12 miles east of Canton and 3 miles west of Minerva. Bids were received on this bridge March 31, 1936. (As yet the contract has not been awarded.) Both bridges are of two spans of 32 feet each. The bridge at Sugar Creek has a 24-foot roadway and two 3-foot sidewalks and requires about 110,000 brick. The Stark County bridge will have a 34-foot roadway, with no sidewalks, and will require about 140,000 brick.

For our first attempt at using reinforced brick masonry, we selected a location near a brick manufacturing center where a reinforced masonry structure was the logical type for the location. There were two brick plants within one-half mile of the site. It was decided to build a T-beam bridge on cantilevered abutments. The next problem to decide was how completely the structure would be built of brick masonry. Because of our lack of experience in designing and building reinforced brick masonry, it was thought best to build the main beams and slab of the superstructure of reinforced concrete, using one of our standard plans. After test borings were made, it was found that foundation conditions were so variable and uncertain that it was probably best for us to retain our usual reinforced concrete footing under the substructure. This later proved to be a wise decision, for upon excavating for these footings, it was found necessary to use piling. This left all of the walls, railing, and sidewalks to be built of reinforced brick masonry. For architectural purposes it was decided to use brick facings on the concrete deck.

(4) Stress Units Selected

Our next problem was the selection of unit stresses to be used in design. Tests had shown

that the modulus of elasticity of brick masonry might vary over a wide range, depending on the type of brick and mortar. Since we were not certain what type of brick would be used in the construction and several different types of mortar were under consideration, it was necessary to select an average modulus of elasticity for the type of brick and mortar which would probably be used. The assumed modulus of elasticity used in the design was two million. After careful consideration of recommended unit stresses, tests from various researches, and other available information, and since we wished to be conservative, the following allowable unit stresses in the design of the reinforced brick masonry were elected for use: compression in the extreme fiber 600 lb. per sq. in., shear in beams without web reinforcement 20 lb. per sq. in., bond 50 lb. per sq. in. for deformed bars, and a tensile stress in the reinforcing steel of 14,000 lb. per sq. in. The design of the reinforced-brick masonry was based on the same assumptions as are customary in reinforced concrete design, and the same formulas applied.

(5) Brick Specifications

In the selection of brick for the structure, it was felt desirable to allow alternate types and sizes both of building and paving brick. This meant that a certain size of brick and thickness of mortar joint must be used in the design for working out the dimensions, patterns, etc., with permission for changes in the design, if an alternate type were used in the construction. The plans carried this note: "This structure is detailed for the use of a brick measuring $2^1/_4$ by $3^3/_4$ by 8 inches because of the proximity of several brick plants making brick of this size. If brick of another size are used, details showing variations in dimensions and patterns must be presented by the contractor and approved by the Bureau of Bridges before laying is started on the brickwork."

Face brick was required to be smooth, dark red, and hard-fired, meeting the A.S.T.M. specification No. C62–30 for hard- or medium-grade building brick, and because of its constant exposure to wetting and drying it was required to meet the absorption test for hard-grade clay sewer brick (A.S.T.M. No. C32–24). Backing brick was required to meet the A.S.T.M. Specification No. C32–24 for hard- or medium-grade clay sewer brick. Paving brick which could meet these requirements were permitted to be used upon approval by the Bureau of Bridges, but the contractor did not elect to use them.

(6) Mortar Specifications

In the selection of mortars, two types were chosen for experimental purposes to determine relative efflorescence, workability, durability, etc. The east abutment was built with 1:3 Portland cement mortar to which 15%, by volume of the cement, of hydrated lime was added. The remainder of the brick masonry was built with $1:2^1/_2$ mortar using a commercial mortar cement. The crushing strength of the mortar cement mortar, although lower than the Portland cement mortar, was sufficiently high to provide a reasonable factor of safety over the design stresses. On the Stark County bridge, 1:3 Portland cement mortar with 10%, by weight of the cement, of hydrated lime is specified. Mortar joints were specified to be $^1/_2$ inch thick with an absolute maximum thickness of $^5/_8$ inch and minimum of $^3/_8$ inch.

II. Detail of Bridge Construction

All brickwork, including the railing, was capped with reinforced concrete as a trim and for the additional function of keeping water from getting down into the masonry from the top. For the bridge to be built in Stark County, brick caps or copings are to be used, with copper flashing separating these caps from the brickwork beneath, similar to the flashing usually used on stone copings.

The sidewalks on the Sugar Creek bridge are designed so that they could be removed to allow for future widening. They are of reinforced brick slabs, $3^3/_4$ inch thick, having one $^3/_8$-inch round bar in each mortar joint, or $2^3/_4$-inch centers. The brick are on edge. These slabs were precast in sections about 3 feet wide or, in other words, built up as 4-inch brick walls 3 feet high with the reinforcing near one face. After proper curing, these slabs were placed in position on a mortar bed. This was done to speed up construction and also to avoid forms under the slab, which would have been required if the slab had been built in place.

The brick facing on the outside beams was placed after the concrete deck was in place. It was supported on copper-bearing steel-shelf angles which had projecting anchors embedded

in the concrete. Metal wall ties were also used between the brickwork and the concrete. The railing was of reinforced brick masonry capped with concrete. It had $^1/_2$-inch open joints between the posts and panels to prevent deck bending stresses being carried into the railing and also to provide for expansion. Our bridge railings are designed to resist a vertical force of 100 pounds per linear foot and a horizontal force of 150 pounds per linear foot applied at the top of the railing. Since a 3-inch wind gap is left under sidewalk railings, this horizontal force must be carried into the structure in bending at the ends of the panels. This required $^5/_8$-inch round U-shaped dowels at each end of the panels and necessitated making a slightly larger joint there than elsewhere.

To minimize efflorescence, special care was taken with the waterproofing of this structure. The back of both abutments in contact with earth was waterproofed with two coats of hot asphalt, of which the total application amounted to about one gallon per square yard. No waterproofing was used on the exposed surfaces of the brickwork. Owing to the alternate wetting and drying of the brickwork, it was especially important to have the brickwork as watertight as possible. Consequently all joints were required to be filled completely with mortar and struck on all surfaces, including the backs of abutments where waterproofing was applied. Grooving of mortar beds with the point of the trowel was not permitted. The bricklayers were not familiar with this type of joint where complete filling was required, and they had to be instructed and watched carefully at first.

Since the bridge was skewed, as the majority of our bridges are, very few of the corners were right angles. The angle of skew was 22 degrees, and we found it difficult to get neat-looking and watertight corners where angles were other than 90 or 45 degrees. For some of the more important corners, brick were cut to angle with a silicon carbide saw. This is an expensive operation, but it is worth the cost on the more noticeable corners for the sake of appearance and as an aid toward obtaining watertight masonry. The Stark County bridge is not skewed, so we will not have this difficulty there.

Where stresses are high and large reinforcing is required, it is difficult to get the bars in $^1/_2$-inch joints. This was especially true on the railing and in the abutment walls. Reinforcing in the abutment at the top of the footing consisted of $^5/_8$-inch round bars at 4-inch centers. It did no particular harm to have a larger joint here, but bars at 4-inch centers interfered with the header or bond courses and brick had to be clipped to go between the bars.

An inspection of the Sugar Creek bridge, made during the third week of March, 1936, the bridge being slightly less than two years old, shows it to be in excellent condition except for discoloration owing to the many floods of the past year. The mortar is all in excellent condition apparently, and neither type of mortar shows an advantage as yet over the other in signs of efflorescence or durability. The only part of the structure which shows any efflorescence is the beam facing on the north side where it is always shaded, and this is not noticeable because there is very little of it and it is fairly uniform over the entire surface.

The writer, having been assigned to make a study of this type of construction, developed the details and design of the bridge at Sugar Creek and reviewed the plans for the Stark County bridge.

NOTE: The first bridge was built under the administration of O. W. Merrell, then Director of Highways, and the development of this type of construction is being continued by the building of the second bridge under the present Director of Highways, John Jaster, Jr. Both bridges were designed under J. R. Burkey, Chief Engineer of Bridges, and W. H. Rabe, Chief Designing Engineer of Bridges. The Sugar Creek bridge was built by the O'Connor-Kipf Co., Cleveland, Ohio, under the direction of Elmer Hilty, Chief Engineer of Construction.

III. Conclusions

Reinforced brick masonry, if properly built, is a sound type of construction that can be used in design by the structural engineer. It took longer to detail a structure of this type than it did using reinforced concrete because of the necessity of making all of the dimensions fit the brick courses. It has been a pleasure, however, to work with this new type of construction, and the completed structure has received favorable comment by the people living in the community in which it was built. Reinforced brick masonry is a lasting and weather-resistant material and its use is justified wherever costs of material and skilled labor are such as to place no great differential in cost between it and other similar structural materials.

BUREAU OF BRIDGES
DEPARTMENT OF HIGHWAYS
STATE OF OHIO

CHECKER BRICK IN OPEN-HEARTH SERVICE*

By William C. Buell, Jr.

I. Introduction

When checkerwork is being discussed, the open-hearth operator usually places first importance on the size of the brick and the method of laying. This has been reiterated by the user, and the brick man has a reasonable alibi if he holds a similar belief.

But there is a much more important factor to effective regenerator operation than the size or shape of checker brick or any method of laying them. This is the fluid distribution to the checkerwork. I often use a phrase which is axiomatic in this respect and worth repeating, "Any design of checkerwork will be as effective only as the distribution of the fluids over and below the checkers."

II. Factors of Heat Distribution

It will be profitable to consider the factors of the distribution somewhat critically. In Fig. 1 the diagrams are plans of regenerator chambers with the fantail directing the gases from the furnace into the upper part of the regenerator at the right and the "connecting flue" which directs the air into the lower part of the chamber after reversal to the left.

The upper diagram, A, is of a regenerator arrangement unusually well laid out. If there were the proper relationship between the entrance area A_{11} and the furnace gas velocity, it is evident the gases could flow over and pass downward through the checker flues with reasonably equitable distribution. In the same way, with proper relationship between area, A_{12}, and velocity, the air might enter the lower chamber and flow upward proportionately through all the flues. Unfortunately, such ideal coördination is never found in actual operation.

(1) Effect of Forcing the Furnace

Unbalanced operation will come chiefly from forcing the furnace for added production, which will develop enlarged fluid volumes that result in excessive entering velocities. When the velocities become relatively great, the fluids through dynamic effects pass to the far end of the chamber where they flow through an adjacent part of the flues only, a considerable portion of the checkerwork remaining ineffective.

Under such conditions, the rear portion of the checkerwork is heated by the furnace gases, while the counterflowing air passes through the forward or cooler portions of the checkerwork. Such operation causes the furnace gases to leave at high temperature, still containing much salvable heat, and the air to be insufficiently heated. Furthermore, as the air does not adequately cool the hottest brickwork, this part overheats and in time causes the operating difficulties with which many of us are familiar and which are often laid to poor brick manufacture or checkerwork type.

(2) Effect of Angling the Intake

Figure 1B illustrates a common condition of faulty fundamental regenerator design. In this, the fantail and the connecting flue is acutely angled, and the deleterious effect on fluid distribution to the checkerwork, as indicated by the shaded portions, is obvious.

Several years ago McLoughlin,[1] in a paper on regenerative furnaces, offered data regarding flow through checker flues under simulated operating conditions. Modified diagrams of the results of this investigation are given in Fig. 2. They are particularly interesting as confirming the prior statements.

Both A and B of Fig. 2 represent the flow of furnace gases in the upper chambers, the fantail in A being slightly angled and acutely angled in B, although not so illustrated. It will be seen that the major flow in both cases follows the right-hand wall and that the gases accumulate and turn through 180° near the rear wall; then traveling along the left-hand wall, they peter out toward the center of the regenerator chamber. The high values at the upper left-hand corner in A as well as the counter-flow conditions are like the product of eddy currents, the result of faulty entrance design.

Figure 2C represents the flow of air in the

* Presented at the Fall Meeting, Refractories Division, September 4, 1936.

[1] T. J. McLoughlin, "Theory and Application of Regenerative Principles in the Steel Industry," *Proc. Amer. Iron and Steel Inst.*, p. 159 (1929); Parts I and II are abstracted from *Blast Fur. Steel Plant* in *Ceram. Abs.*, **8** [8] 586; [10] 744 (1929).

underchamber and shows the considerable extent to which the air piles up in the far end as a result of excessive velocity. As a matter of fact, the four rows of flues nearest the furnace, about 15% of the total, receive nearly 50% of all the air, while the volume entering the flues near the inlet end is relatively insignificant.

This figure shows conclusively that the larger part of the furnace gases pass through the rearward flues and most of the air through the forward flues. This condition, which is quite commonly found in practice, results in the fusion or softening of the top rear checkerwork with loss of transfer effectiveness.

The foregoing comments have concerned horizontal distribution, but vertical distribution is almost as much a factor in effective checker operation as is the horizontal.

Figure 3 shows a vertical longitudinal section through the common box-type regenerator chamber.

The acutely angled lower surface of the fantail at the upper left is almost universally present in a greater or lesser degree in all open-hearth regenerators. Again, if the velocity at A_{11} is too great, it is evident that there will be a tendency for the entering gases to pass entirely over the front checker flues, to ricochet from the roof and to enter the flues toward the rear, thus accentuating the faults of horizontal distribution. Even with the best conditions of distribution there will be certain sections of the checkerwork, as indicated by the shaded portions, that will be ineffective as a result of inherent flow factors.

The correction of the ordinary faults of flow is chiefly a matter of fundamental furnace redesign. There are but few open-hearth furnaces in the country that were "designed" in the true meaning of the word and when, as at present, the furnaces are being pushed for tonnage, the faults magnify and the operating head makes frantic efforts to correct fundamental faults by such extraneous methods as changing checkerwork design. Such efforts are entirely useless.

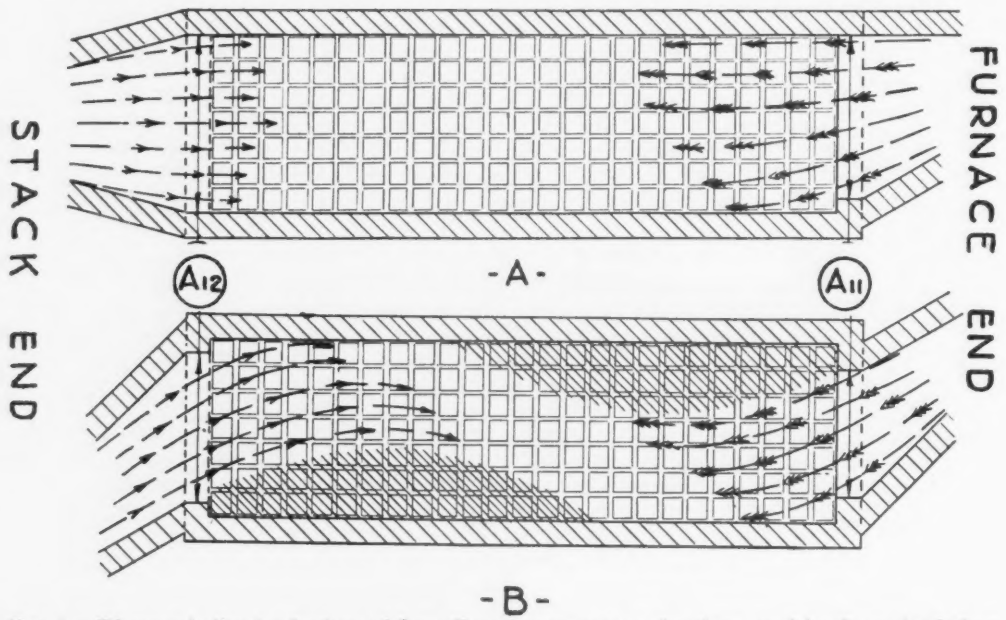


FIG. 1.—Diagram indicating horizontal flow effects in regenerator chambers resulting from the design of the contiguous components.

The stepped-type checkerwork, Fig. 4, which is quite commonly in use, may somewhat improve faulty distribution conditions and the volume of the checkerwork may be increased slightly by its use. It may be easily and inexpensively installed. The dimensions shown in Figs. 3 and 4 apply to a specific case and have no general significance.

Carefully designed horizontal flue and multiple-pass regenerators may assist greatly in the solution of distribution problems as well as in bettering general regenerator conditions. The subjects

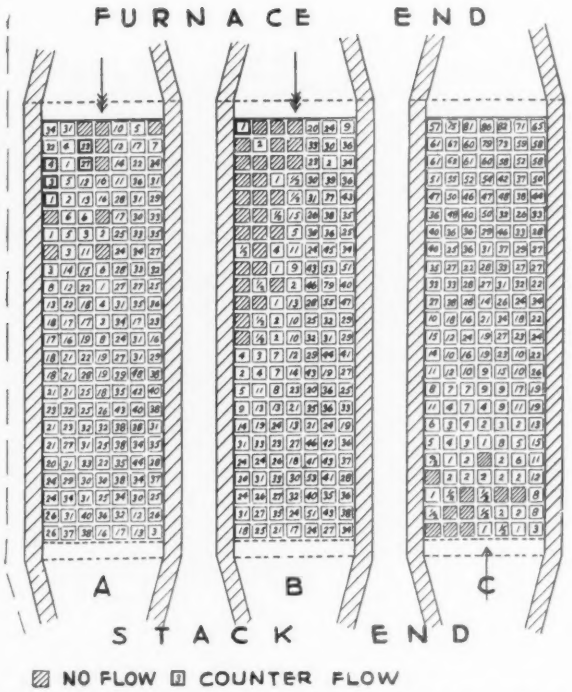


FIG. 2.—Modified diagrams of McLoughlin's research in flow through checkers; values given are feet per second velocity as at 32°F.

can not be adequately treated at this time, and further reference to these excellent designs, which so far have not found general favor in the United States, is omitted.

III. Metallurgical Factors

Thus far, consideration has been given only to fluid distribution, but the process effects will now be discussed. King[2] has shown the average weight of dust deposited through the checkerwork or in the bottom of the regenerator to give the following averages:

Type of firing	(lb./ton ingots)
Producer gas	3.8
Natural gas	1.0
Tar	6.0–12.0
Coke-oven gas	1.8

From his figures the average composition of the dust may be found as follows:

	(%)
SiO_2	2.0–11.0
FeO	0.5– 5.5
Fe_2O	53.0–86.5
MnO	0.4– 1.2
Al_2O_3	2.4– 9.1
CaO	1.5– 7.6
MgO	0.9– 3.7

[2] C. D. King, "Basic Open-Hearth Yields," *Trans. Amer. Inst. Mining Met. Engrs.* [Iron and Steel Div.], p. 197 (1929).

As deposited on the floor of a regenerator chamber after passing through the checkerwork, the dust is a very fine solid and probably inert in its reaction to the brickwork, but when entering the

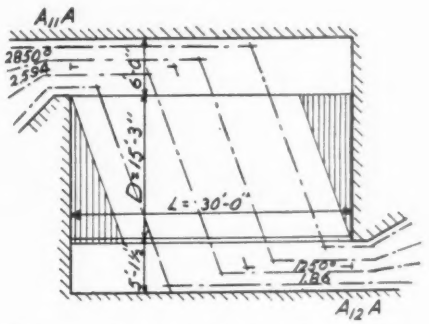


FIG. 3.—Vertical flow through the common box-type regenerator.

chamber at temperatures approaching 3000° it is in a fused or semifused condition and, if driven inward as a result of gas stream velocity, it will adhere to and react with the highly heated brickwork at the upper checker surfaces or the side or end wall of the chamber.

The fouling of the checkerwork, which is a very important factor in economical operation, starts the instant a newly built or rebuilt furnace is put into operation, and often severe fouling of the checkerwork rather than the condition of the upper furnace brickwork, brings the campaign to a close.

The data shown in Fig. 5 are interesting in this connection. In one plant, the tonnage and fuel rates throughout each furnace campaign for several years were recorded and combined into a curve for each year. Thus, in 1929, 753,000 tons of ingots were produced and at the beginning of each campaign the furnaces produced

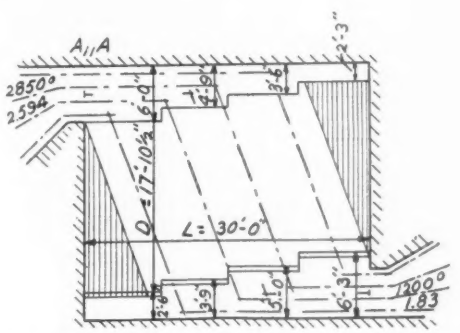


FIG. 4.—Stepped-type checkers, the use of which improves distribution as compared to the box type.

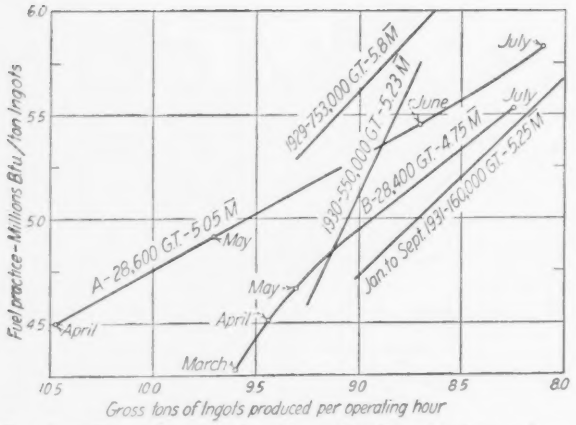


FIG. 5.—Chart showing the effect of fouling checkerwork on fuel and production rates.

9.75 tons per hour on 5,200,000 B.t.u., but at the end of the campaign the tonnage rate had fallen to 8.75 and the fuel rate raised to 6,000,000 B.t.u. In 1930, with 550,000 tons ingots production, the hourly tonnage was about the same as for the prior year, but the fuel rate was materially less, largely from the fact that the furnaces were actually operated by the personnel that ordinarily supervised operations. The poor tonnage rates of 1931 resulted from intermittent operation and other depression factors. Most of the checker brick used in these years were 9-inch regular and $13^1/_2$ by 6 by 3 inches, and the average campaign was well over 40,000 tons production. The fouling of the checkerwork is almost entirely responsible for the decreasing tonnage and increasing fuel rates as the campaign gets older.

The line, *A*, represents a campaign with a patented block-type checker, such as is used in blast-furnace stoves.

This furnace started out with fine fuel and tonnage rates and was coddled throughout its campaign, but the checkerwork was so clogged after 28,600 tons had been produced that the furnace became virtually inoperable and had to be rebuilt.

The performance of the checker brick (line *B*) was quite similar to that cited above. The patented brick, however, were of the unit type and were laid "staggered." Incidentally, it is quite an important economic factor that special checker tile or brick have little if any salvage value.

IV. Checkerwork

The common methods of laying checker brick are illustrated in Fig. 6. *A* is the open-flue type with all brick standing on edge, while *B* is a similar type but with alternate courses on edge and side and is used to develop greater structural stability. In both of these types, the clear opening extends from top to bottom. *C* is the staggered type which obviously is used to magnify turbulence in the gas streams. The lower part of the plan view shows the brick staggered in one direction only and in the upper part they are staggered in both directions.

E is the chimney-type checker having plane brick surfaces without cross-flues the entire height.

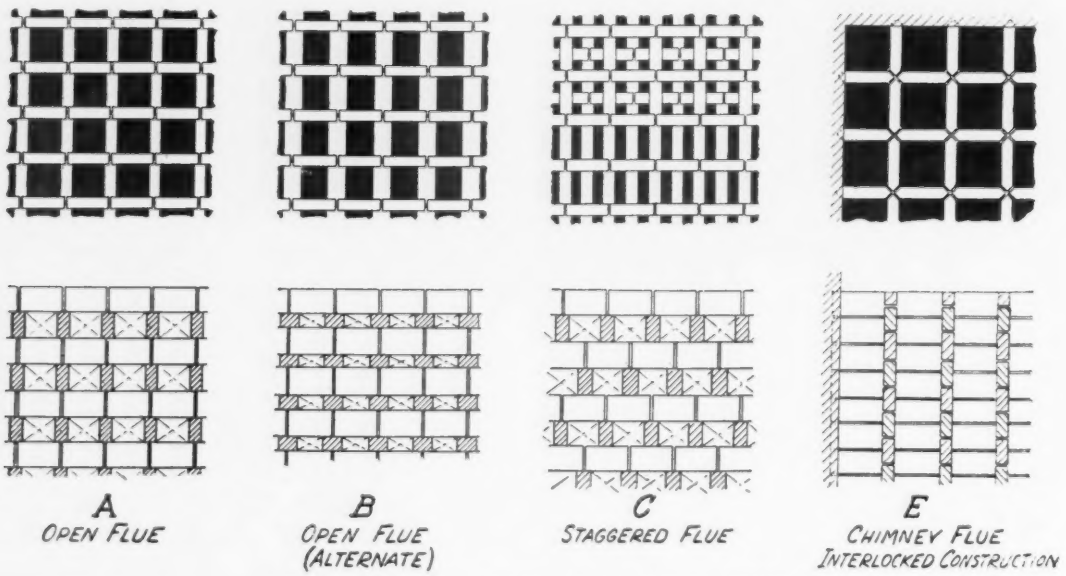


FIG. 6.—Common methods of laying checker brick.

A discussion on the moot question of checker brick and flue size follows.

If, as a prerequisite of correct regenerator operation, we amend the designs to solve the problem of distribution, the brick or flue size is not particularly important so long as the flues are large enough. During a tar-fired 40,000 ton campaign, there will be deposited in the regenerator chambers at each furnace end 60 or more tons of dust. The only way in which this dust will not react adversely to operations and costs is to have it deposited where provision is made to receive it, on the regenerator floor. This at once calls for open checker flues of ample size. Thus, in my own practice I like to use flues having openings 9 to $13^1/_2$ square inches, with a preference toward the larger size.

To the advocates of small or staggered flues who argue that methods of creating gas turbulence are necessary to rapid heat exchange, I am yet unconvinced that in a 12- to 16-foot long firebrick flue of small area it is possible to produce stream-lined or nonturbulent flow or that in a gas column, 12 inches square, it is possible to maintain any material temperature differential between the center and the surface of such a column. Granting that the smaller flue will develop more heating surface per unit volume in nowise minimizes the operating fact that the smaller the flue the greater the probability of early plugging.

V. Checker Maintenance

As to the maintenance and renewal of checkerwork, with poor furnaces or operations, a campaign may cover only 150 heats, while under modern conditions the campaign may exceed 400 heats. Checkerwork life follows quite closely the general plane of operation and may be expected to be about three campaigns in any practice. Thus, about one-third of the total checker brick must be replaced at the end of each run.

The older and common method of renewing the checkers is (1) to remove the top third of the brick, (2) to lance or otherwise clean the flues of those remaining in place to remove as much dust from the regenerator bottom as may be conveniently reached, and (3) to place new brick in the upper third. Thus the brick toward the bottom progressively foul from run to run and become less effective as heat-transfer media until operation becomes so poor that it is mandatory to renew the entire checker volume. In such practice it is plain that a furnace can be at the maximum peak of its operating efficiency only at such times as the entire checkerwork is new.

The enlightened method now practiced in a few progressive plants is to remove all checker brick after each campaign, which allows thorough removal of all regenerator dust. The required new brick are laid at the bottom and the older brick are moved up so that what was the middle third in the previous campaign becomes the upper third in the succeeding run. This method is not at all costly in labor; many well-seasoned brick which are no longer effective as checkers may be salvaged for reuse in the heating furnace or other brickwork; a minimum are sent to the dump.

The great advantage of the method is, however, that at the beginning of every campaign the furnace goes into production at its maximum checker efficiency which means less fuel, more tons of steel per hour, and less ingot cost.

VI. Conclusions

(1) The most important factor of regenerator design and operation is the horizontal distribution of the incoming fluids.

(2) Horizontal fluid distribution is a function of fundamental furnace lay-out, design, and operation and is but slightly, if at all, affected by checkerwork design.

(3) The depositing of the dust in selected locations is of major importance to the continued effective operation of checkerwork.

(4) The most carefully conceived checkerwork will be ineffective to a varying and generally considerable degree as long as horizontal distribution and dust elimination are faulty.

(5) Given the best possible conditions of distribution and dust elimination and bearing in mind the usual conditions of operation, it seems probable that checker design may be varied through considerable limits without materially changing operating results.

(6) Large checker flues offer substantial operating advantages.

(7) Cleaning and renewal practice has a considerable effect on over-all practice and results.

Thus, checker brickwork as such actually plays but a minor rôle in the operation of a regenerator, although it is almost always named as the acute cause of its constitutional ills.

ENGINEER, P.O. BOX 6093
CLEVELAND, OHIO

THE INFLUENCE OF MATERIAL, SHAPE, AND SIZE OF CHECKER BRICK ON HEAT TRANSFER IN REGENERATORS*

By J. D. Keller

I. Introduction

Although regenerators have been in use for many years on open-hearth furnaces, steel-reheating furnaces, and glassmelting furnaces and much study and mental effort have been expended upon them, the subject still seems to be involved in obscurity, which permits all sorts of questionable ideas to pass current. Thus, the impression seems to be widespread that the *material* of the checker brick is very important as to their efficiency as heat-transmitting surfaces and that a really remarkable improvement might be effected by the substitution of a different material. There is also perennial discussion relative to the merits of other-than-standard shapes of brick and of various arrangements of setting. It is the object of this paper to clarify these matters by stating them in the simplest possible manner, referring to heat-transmitting characteristics only and excluding (except for incidental mention) questions of strength or stability and durability.

II. Rôle of Thermal Conductivity of Brick

Comparisons are often made on the basis of the physical or thermal properties of the checker-brick materials alone. While these comparisons may be correct in themselves, the conclusions drawn from them are entirely wrong, because the material factors (thermal conductivity, density, and specific heat) are so far outweighed by other factors, independent of the material, that even as great a difference as 10 to 1 in the thermal conductivity, for example, affects the overall-heat transfer coefficient in the usual checker only to the extent of 6 or 7 %.

To understand the reasons for this, we must first get a general picture of the mechanism of heat transfer to and from the brick. Referring to Fig. 1 (*a*), the curves show the temperature distributions existing in one-half of a checker brick at various times during the "on-air" period of the cycle, as determined from actual measurements made by Trinks and the writer on an experimental regenerator with thin-wire thermocouples imbedded in the brick at various depths below the surface (although these curves can also be determined by calculation, by the use of Fourier series or of the Schmidt difference-calculus method). The upper dotted-line curve shows the temperature distribution throughout the half thickness of the brick, just at reversal. The dotted curve just below it, with the reverse curvature, corresponds to a time about one minute after reversal, and the succeeding lower curves refer to correspondingly later times. The lowest dotted curve applies to the instant of reversal from "on air" to "on gas." During the latter period, the temperature curves (not shown) are similar to those for the "on-air" period, but they are inverted.[1]

The *average* temperature in the brick during the "on-air" period, averaged over the entire time period, is shown by the lower solid-line curve, while the average temperature in the same brick during the "on-gas" period is shown by the upper solid-line curve in Fig. 1 (*a*). At any instant, heat is flowing into the checker brick in the regenerator chamber on one side of the furnace, and heat is flowing out of the checker brick on the other side of the furnace. Considering the checkers on both sides of the furnace during the same period, we can swing the lower solid-line curve about the center line of the brick from left to right, and thereby get the diagram of Fig. 1 (*b*). It then becomes evident that the checker brick, in its action, is equivalent (when considered over a full cycle) to the wall of a tile recuperator, through which heat is transmitted continuously, as shown by the right-hand diagram (Fig. 1 (*c*)).

For calculation purposes, then, as far as average temperatures are concerned, the actual regenerator brick can be replaced by an equivalent thinner recuperator wall and the heat transfer in the regenerator can be estimated in exactly the same manner as in a tile recuperator. Thus in Fig. 1, the $2^1/_2$-inch brick are equivalent (when the reversal period is 15 minutes) to a tile recuperator wall of about $^3/_4$ inch thickness.

* Presented at the Fall Meeting, Refractories Division, September 4, 1936. Received October 29, 1936.

[1] It should be understood that the actual temperatures shown in Fig. 1, which are in degrees Fahrenheit, are averages for the checker; that is, they apply to a brick located, not at the top or at the bottom of the checkerwork, but at about the middle of the height.

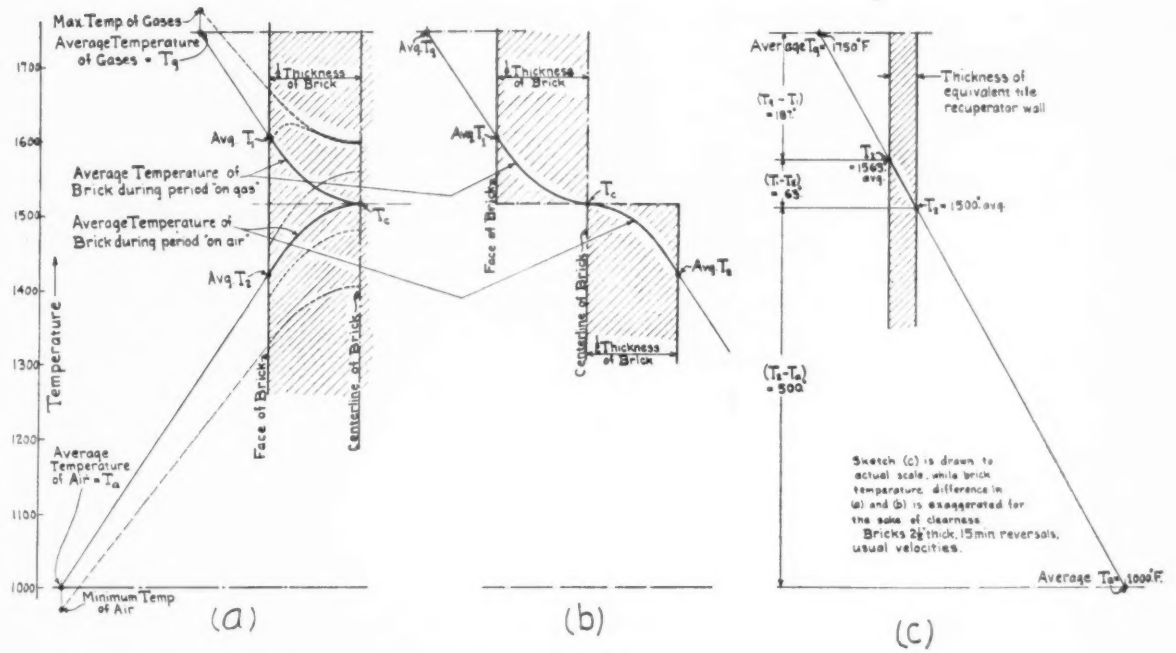


FIG. 1.

III. Total Resistance of Brick to Heat Flow

Just as in the flow of electricity, so in the flow of heat we can utilize the concept of resistance to flow, which is the reciprocal of conduction. Assuming uniform operating conditions to have been reached, the (average) rate of heat flow from the gases to the brick surface equals the rate of heat flow into and out of the brick which equals the rate of heat flow from the brick surface to the air. This being the case, the various temperature drops are proportional to the corresponding resistances.

Part (*c*) of Fig. 1 has been drawn to scale to represent conditions in a typical open-hearth regenerator, and from it we see that by far the greater part of the resistance is on the air side; that is, it is much more difficult to get the heat out of the brick into the air than it is to get the heat out of the gases into the brick or to conduct it within the brick. On the average, the air resistance accounts for about two-thirds of the total, the gas resistance about one-fourth, and the brick resistance only one-twelfth, or about 9% of the total. It at once becomes evident that any improvement by the use of different material for the brick can result in not more than 9% gain at the best, unless the different material can also improve the heat transfer to the air.

The 9% applies to $2^1/_2$-inch brick and 15-minute reversals in ordinary checkers. For thicker brick and longer reversals, or for secondary checkers with high air velocity, the possible gain is greater, because in those cases the brick resistance is a greater fraction of the total. Thus, for $4^1/_2$-inch brick and 30-minute reversals, the brick resistance is more than one-eighth of the total.

Where the fuel is producer gas or mixed gas, it is preheated in gas checkers. In these, the heat-transfer coefficient from brick surface to fuel gas is nearly as high as that from the waste gases to the brick, because the fuel gas takes up heat not only by convection but also by absorption of radiation in the carbon dioxide and water-vapor contained in it. The proportions (for $2^1/_2$-inch brick thickness and 15-minute reversals) then become: fuel-gas resistance, $^1/_2$; waste-gas resistance, $^3/_8$; and brick resistance $^1/_8$ or $12^1/_2$% of the total. The overall heat-transfer coefficient in the gas checker is therefore increased about 60% over that of the air checker. In checkers for preheating mixed gas, however, advantage can seldom be taken of this improved heat transfer to reduce the size of regenerator, because with mixed gas the chief desideratum is cracking the hydrocarbons to produce a luminous flame in the furnace; and cracking requires not only high temperature but sufficient *time*. In order to allow the gas plenty of time to crack before entering the furnace, the gas checker is sometimes made

as large as the air checker, although this would not be required for heat transfer alone.

In glass-tank practice, the velocities and temperatures in the checker differ somewhat from those in open-hearth checkers, but the difference in the heat-transfer coefficients is not sufficient to change appreciably the relative proportions.

IV. Effect of Brick Properties

Studies, calculations, or even tests, which consider only heat conduction within the brick, are likely to prove misleading, because they emphasize only one of the three factors and neglect to consider its relatively small importance.

The properties of the material of the brick which affect the brick coefficient are thermal conductivity, density, and specific heat. The values of these properties for various materials are given in Table I.

TABLE I

Material	Av. conductivity at 1600°F (B.t.u./sq. ft./hr. °F/in.)	Specific heat at 1600°F = Cp	Av. density = W (lb./cu. ft.)	Ratio of conductivity to that of fire brick	Ratio of $W \cdot Cp$ to that of fire brick
Fire brick	9.5	0.255	125	1	1
Silicon carbide	110.0	.255	150	12	$1\frac{1}{4}$
Magnesite	27.0	.278	162	3	$1\frac{1}{2}$
Insulating brick	2.5	.255	33	0.25	$\frac{1}{4}$
Cast iron	282.0	.155	450	30	$2\frac{1}{4}$

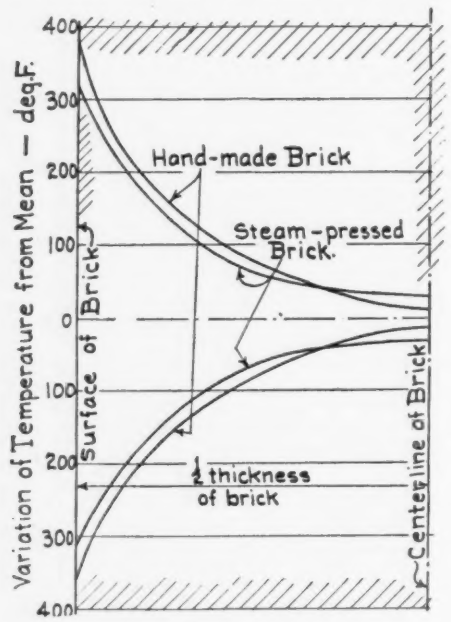


FIG. 2.

From a heat-transfer standpoint, the conduceivity, specific heat, and density should have as high values as possible. On that basis, it would seem at first glance that cast iron, if only it could be used, should be about thirty times as good, and silicon carbide about twelve times as good, as fire brick.

When we look at the entire picture, however, the discrepancies between most of the materials shrink so as to become almost negligible. Even a perfect conductor would show a difference between the average temperature during the gas period and the average of the air period (the specific heat and density being finite) on account of the logarithmic curvature of the lines, but in all practical cases this difference is quite small.[2] To it is added, in actual materials, the difference due to the finite conductivity.

While (T_1 av. $-$ T_2 av.) for cast iron is only about one-eighth and, for silicon carbide, one-fifth as great as for fire brick, the gain in the overall heat-transfer coefficient amounts only to $7\frac{1}{2}\%$ and $6\frac{1}{2}\%$, respectively, for an ordinary checker.

Another case in point is that of a test made by Trinks and the writer in 1920, comparing two kinds of fire brick (hand-made fire brick of a well-known brand and steam-pressed brick) in an experimental regenerator. The maximum temperature variation throughout the half-thickness of the brick is shown in Fig. 2.

At first glance, the steam-pressed brick looked decidedly superior; its conductivity was about 15 % higher, the material in the center was better utilized, and the variation of surface temperature was less. On the other hand, the average temperature change of the material was less also, and, even allowing for the difference in density of the two brick, the amount of heat absorbed and given up per unit of area figured out considerably less for the steam-pressed brick than for the hand-made brick.

This apparent contradiction is explained by the difference in the heat-transfer coefficient from brick surface to air, and to a smaller extent

[2] See A.I.M.M.E. Open-Hearth Comm. Minutes, June 28, 1934 (Fig. 2).

in that from the gases to the brick surface. The hand-made brick had a noticeably rougher surface, which not only increased the radiation-absorbing capacity, but, more important, it also increased the turbulence of the air flow or gas flow along the brick surface and thereby raised the convection coefficient. The net result was that the hand-made brick gave about 8% greater heat transfer than the steam-pressed brick, when both were new. (This was for thicker brick and longer periods between reversals than are now usual.)

In an actual checker chamber, however, dust soon deposits on the surfaces or glazing by slag occurs, and the surfaces of both brick would gradually become alike. The greater conductivity of the steam-pressed brick would then make it slightly the better heat transmitter. Hence, over the whole life of the brick in a regenerator, it is doubtful whether there would be any measurable difference in the effectiveness of these two kinds of fire brick.

The conclusion that little could be gained in heat-transfering capacity by substituting different materials for fireclay checker brick applies to all ordinary types of checker. For special designs, it may not apply. For example, in the Dyrssen or the Ljungstrom regenerators, if an attempt were made to use fireclay tile instead of metal plates, it is conceivable that with the very short reversal periods employed, the low conductivity of fire clay would make this material unsuitable, even if it were not ruled out by its fragility when made in thin sections such as required for these regenerators. In multipass checkers with pusher fans, if the velocities were carried to considerably higher values than any so far attempted, the brick resistance might become proportionately so large as to warrant consideration of other materials than fire clay.

V. Effect of Brick Porosity

Recently, it has been suggested that porosity is desirable in checker brick because "breathing" or alternate penetration of air into and exhalation out of the pores resulting from the rise and fall of temperature of the brick, assists in transferring heat into the interior, and vice versa.

Lamort[3] has studied this question and concluded that the effect on heat transfer is negligible; in any case, it obviously acts in the wrong direction, because air is penetrating into the brick at the time when the latter is cooling and heat is being conducted outward, and air is being exhaled and carrying heat outward when the brick is rising in temperature and heat is being conducted inward. Aside from the matter of heat transfer, "breathing" is undesirable from the standpoint of durability of checker brick, because it carries deleterious vapors into the interior of the brick. This is especially serious in blast-furnace stoves, where the great changes of pressure (20 to 25 lb. per sq. in.), as pointed out by McKee, cause the breathing to be much greater than that due to temperature variation alone.

VI. Size and Setting

These two factors should be so chosen as to give the greatest possible area in a given volume and at the same time to obtain a high overall heat-transfer coefficient. As we have seen, the determining resistance to heat flow is on the air side. Heat transfer from brick to air is produced almost entirely by convection, the radiation being negligible. Hence, the setting should be such as to produce the greatest turbulence of air flow obtainable without exceeding the available draft loss.

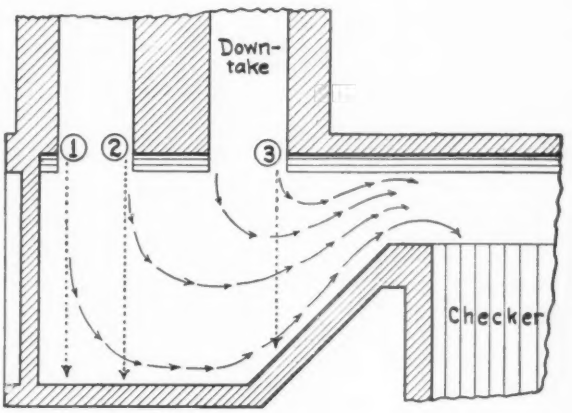


FIG. 3.

The maximum area of heating surface in a given volume is obtained when the width of flue is equal to the thickness of the brick. But the brick should be thin (not over $2^1/_2$ inches for usual reversal periods) or the interior of the brick will be imperfectly utilized; while, in open-hearth practice, flues must be large to prevent or

[3] J. Lamort, "Selection of Checker Brick from the Thermal Viewpoint," *Glashütte*, **66** [2] 32–35; [3] 51–55; [6] 94–96; [7] 108–10; [8] 132–34 (1936); *Ceram. Abs.*, **15** [7] 208 (1936).

minimize clogging by dust. The usual width in open-hearth checkers is about $6^1/_2$ inches, but they have been made as large as $10^1/_2$ inches and as small as $3^1/_2$ inches. The smallest allowable width depends on the rate of driving the furnace, on the gas velocities, and especially on the arrangement of the slag pocket In all present

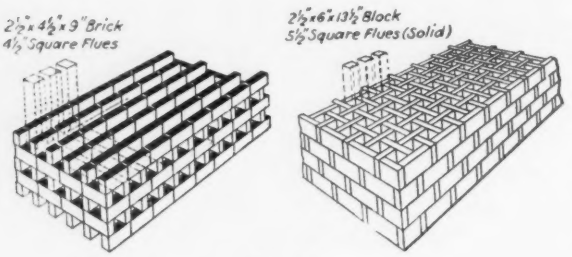


FIG. 4.

designs of slag pocket, part of the gases must cross the path of some of the dust particles traveling downward; they are picked up and carried into the checkers.

Referring to Fig. 3, particles at (1) are free to fall to the bottom; those at (2) must cross part of the gas flow, while particles at (3) would have to cross the whole gas stream to reach the bottom. If someone could invent a really effective dust-catching slag pocket, many things could be done with open-hearth checkers which can not be done now.

At present, the primary checkers are often set with large flues and act as an auxiliary dust catcher, allowing secondary checkers to be used with considerably smaller flues. The use of "wells" in the top courses of the checkerwork also permits smaller flues to be used than would otherwise be possible.

In glass-tank practice, of course, no slag pockets are used; the gases pass directly from the downtakes into the checkerwork. Batch dust is carried over, at a rate which depends largely upon the velocity of the flame across the bath. Because clogging of the checker flues therefore usually occurs at a slower rate than in the open-hearth, somewhat smaller flue sizes can be used.

Trinks[3] shows the effect of varying the thickness of the checker brick as related to length of periods between reversals. The variation shown affects only the brick coefficient, which, as stated above, usually represents only 8 to 12% of the total resistance.

(1) Type of Setting

The two types of checker setting most widely used at present are the standard checkerwork and the solid-chimney type (both shown in Fig.

TABLE II

EFFECT OF SIZE OF REGENERATOR FLUE AND OF BRICK THICKNESS (BRICK $4^1/_2$ IN. DEEP)

From Trinks' Industrial Furnaces (see footnote 4)

Side of flue (in.)	Thickness of brick (in.)	Cross-section of unit cell (sq. ft.)	Heating surface/cell/foot length (sq. ft.)	Heating surface/cu. ft. of checkerwork (brick + open spaces) (sq. ft.)	Weight of fireclay brick/cu. ft. of checkerwork (lb.)	Ratio of free area to total (plan) area
			Standard Checkers			
$2^1/_2$	$1^1/_4$	0.0976	0.682	7.00	42.0	0.444
	$2^1/_2$	.173	0.949	5.48	62.5	.250
$3^1/_2$	$1^1/_4$	.156	0.873	5.59	33.1	.546
	$2^1/_2$	.250	1.163	4.64	52.1	.340
$4^1/_2$	$1^1/_4$	.230	1.063	4.61	27.4	.613
	$2^1/_2$	.342	1.378	4.04	44.8	.412
	$4^1/_2$	.562	1.870	3.32	62.5	.250
$5^1/_2$	$1^1/_4$	.315	1.255	3.98	23.3	.664
	$2^1/_2$	.445	1.593	3.57	39.1	.472
	$4^1/_2$	.693	2.066	2.98	56.3	.302
$6^1/_2$	$1^1/_4$	.416	1.445	3.46	20.3	.705
	$2^1/_2$	.562	1.805	3.21	34.7	.520
	$4^1/_2$	.840	2.380	2.83	51.1	.349
			Solid Chimney Checkers			
$4^1/_2$	$1^1/_4$	0.230	1.500	6.51	48.4	0.613
	$2^1/_2$	.342	1.500	4.38	73.4	.412
$5^1/_2$	$1^1/_4$	.315	1.833	5.80	42.0	.664
	$2^1/_2$	.445	1.833	4.10	65.8	.472

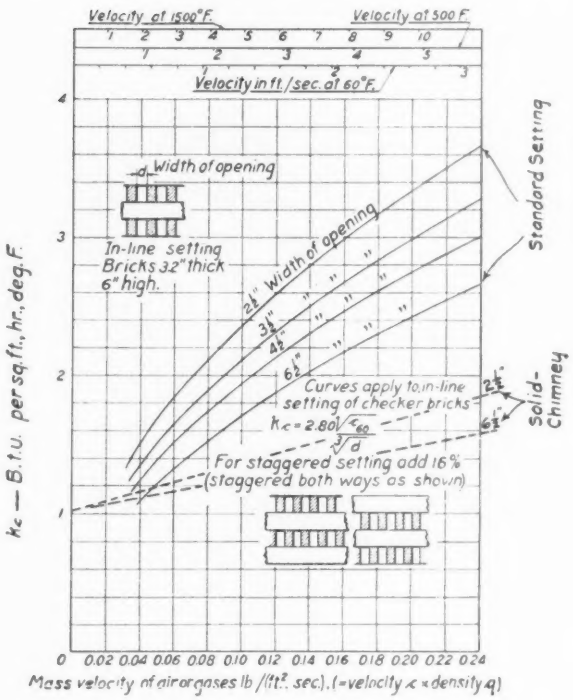

Velocity at 1500°F.
Velocity at 500°F.
Velocity in ft./sec. at 60°F.
Standard Setting
Solid-Chimney
d Width of opening
In-line setting
Bricks 3/2" thick
6" high.
2½" Width of opening
3½" " " " "
4½" " " " "
6½" " " " "
Curves apply to in-line setting of checker bricks
$h_c = 2.80\sqrt{\frac{c_{60}}{d}}$
For staggered setting add 16%
(staggered both ways as shown)
h_c — B.t.u. per sq. ft., hr., deg. F.
Mass velocity of air or gases lb./(ft.², sec.), (=velocity × density q)

FIG. 5.

4). Table II[4] shows how the heating surface depends on flue size and brick thickness for the two types. The advantage of small flues, where it is practicable to use them, stands out clearly.

Comparing the two types of setting, the solid-chimney checker has more actual area of heating surface and a greater weight of brickwork per cubic foot than the standard setting; the surface is more effective for absorbing heat by radiation from the gases, and all of it is available for convective heat transfer; there is a slightly greater weight of brick material per unit of area from which the surface can draw heat; and this setting is more stable and durable, each tile being firmly held against toppling over.

On the other hand, if any of the flues become bridged over at the top, they are entirely lost, because the gases cannot flow sidewise, whereas in the standard setting the air and gases can partly obviate the clogging by lateral flow. Furthermore, convection is certainly more effective in the standard setting, because the open spaces between the horizontal brick surfaces cause and maintain great turbulence of flow. This has now been definitely shown by the tests on the large experimental regenerator of the Verein Deutscher Eisenhüttenleute.

The heat-transfer coefficient for convection, as determined by Kistner on checkers with standard setting and by Böhm on the solid-chimney setting, are shown in Fig. 5. The coefficient averages about 50% higher for the standard setting. The difference in the overall heat transfer, however, can not be great; apparently all of the conflicting influences just about balance, since close observation of different checkers in practice has failed to show any advantage of one over the other. For a given size of checker chamber, the preheat temperature is about the same for both types of setting.

In the standard setting, if the brick are set double-staggered instead of in line, the coefficient is increased 16%, but the probability of clogging is much greater, and cleaning is almost impossible.

One place where it does not pay to do too good work is in the setting of solid-chimney checkers, for the tests showed that then the tile were set so as to increase the roughness; owing to lack of alinement of the brick at the joints the convection coefficient was actually increased as much as 25% at the higher velocities.

Because of the fact that the deposition of dust occurs most rapidly at the top of those flues which are directly under the downtakes and soon closes them up, the solid-chimney type of checker setting is not favored in glass-tank practice.

The method of setting apparently has little influence on "channeling" or uneven distribution of air and gas flow, since this largely depends on the proportions of inlet and outlet ducts. Close setting, if practicable, should tend to reduce channeling to some extent.

VII. Shape

The shape of the brick can, to a considerable extent, affect the turbulence of flow and the convective heat transfer. As compared with a smooth surface in a solid-chimney setting, the increases produced by various shapes which increase the roughness of the surface, are reported by Rummel.[4] By using the most favorable shape, the ratchet-tooth shape with the direction of air flow such as to strike the inclined faces rather than the face of the notches, it is possible to in-

[4] W. Trinks, Industrial Furnaces, pp. 212 and 219, Vol. I, 3d ed. (1934).

[5] A.I.M.M.E. Open-Hearth Comm. Minutes, 1934.

[6] K. Rummel, "Drafting Blast-Furnace Recuperators," *Arch. Eisenhüttenwesen*, **6** [9] 175–85 (1933); *Ceram. Abs.*, **13** [1] 15 (1934).

crease the turbulence in solid-chimney checkers sufficiently to obtain a heat transfer coefficient equal to or even slightly greater than that of the standard setting, while retaining the other advantages of the solid-chimney setting as mentioned above, including the somewhat greater area per unit of volume. Whether the gain is sufficient to warrant the extra cost of special tile seems doubtful.

There is also some doubt as to whether the higher heat-transfer coefficient will still be obtained after dust has lodged on the surfaces.

Finally, there is the question of draft loss. Rummel recommends a modification of the ratchet-tooth shape as utilizing a given draft loss to best advantage for obtaining high heat transfer. In most open-hearth and glass-tank checkers, however, the draft loss in the checkerwork (except when clogged) is so very small, in comparison with the losses at bends and in the valves, that this point seems of minor importance. The recommended shape has the disadvantage that, in the low-velocity region of streamline or laminar flow, the coefficient is increased only 10% over smooth flues, the large increases being obtained only at velocities considerably higher than those usually present in American practice.

Whatever the reasons may be, the use of special shapes of checker tile or even of special settings of standard brick, has not become popular in the United States. In Fig. 6 are shown three designs which have actually been used in this country, together with a tile shape actually in use in Germany. Before discussing these special checkers, it should be emphasized that each has its good points, together (naturally) with some disadvantages. Figure 6 (1) has tile quite similar to those recommended by Rummel. The setting permits lateral flow, while holding the tile rigidly. It is claimed that bridging-over by dust deposits is not so likely to occur. With proportions formerly used, the heating surface per unit of volume was considerably smaller than in the standard setting; in late designs, the surface area has been brought up to a parity with the standard setting, but the gain has been in the area of the flat vertical surfaces rather than in that of the shaped tile. It is possible, however, that the turbulence created in the flow by the latter tile will extend over a sufficient fraction of the vertical surfaces to increase the heat-transfer coefficient over that of solid-chimney flue surfaces.

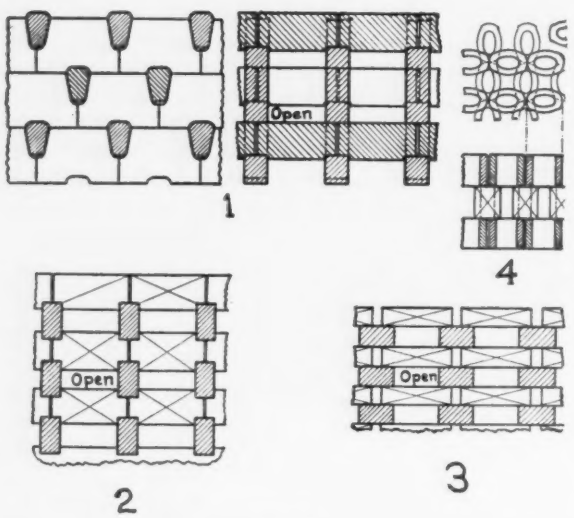


FIG. 6.

The disadvantage of reduced heating surface is overcome in setting No. 2 (Fig. 6), in which the area per unit volume, for a given flue size, is greater than in the standard setting. Notched brick, however, are required.

Number 3 also provides greater area than the standard setting, without the use of special brick. It is questionable whether the additional area is utilized, however, for it is all on the horizontal surfaces. While the flow in the usual regenerator undoubtedly has a horizontal component, this is certainly small; the air or gases must be more or less stagnant at the middle of the spaces between adjacent horizontal surfaces and both convection and radiation to these places are reduced; while the distance of heat flow in the brick is greater perpendicular to those faces on which heat flow is active.

Number 4 permits the use of thin tile, with large heating surface, provides for lateral equalizing flow within the checkerwork, permits cleaning, and at the same time has great stability. It would seem worthy of trial in this country.

Figure 7 (part 1) shows an individual checker tile of a type recently brought out in this country, and Fig. 7 (part 2) shows the tile in a regenerator setting. The advantages claimed are reduction of dust deposits due to the round shape, increase of turbulence of air and gas flow, with corresponding increase of heat-transfer coefficient but reduced friction loss (again due to the round shape), and freedom of lateral flow. The heating surface per cubic foot of checker volume figures

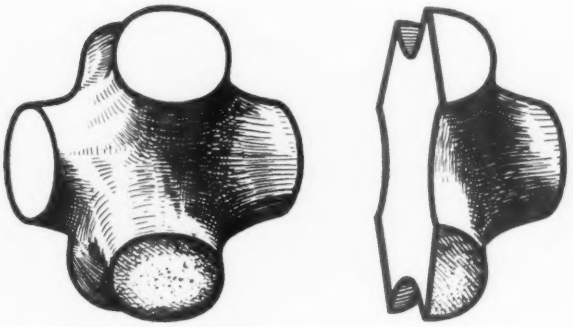


FIG. 7 (part 1).

out about the same as for standard checkers having the same width of flues or openings, but the free area for vertical gas flow is less per square foot of checker-chamber area in a horizontal plane and, correspondingly, the weight of brick per cubic foot of checkerwork is considerably greater. The material of the projections apparently will be more effectively utilized, but that in the core less effectively utilized than in ordinary rectangular brick. It also appears questionable whether the checkerwork will have as great stability as the standard form of checker.

VIII. Weight of Checkerwork

It has been stated before and should again be emphasized that what is desired in a checker is heating surface rather than weight. True enough, a checker could be constructed with sufficient heating surface but insufficient weight. The result would be excessive fluctuation of the air temperature during the cycle. In all actual open-hearth and glass-tank checkers, however, the weight of brick is sufficient to keep the fluctuation from exceeding about 100°F during reversal periods of the usual length. It may be argued that a greater weight of checkerwork would slow up any unbalancing of the two sides of the furnace, due to carelessness of the operators in not reversing exactly at the right times, making the on-air period persistently longer on one side of the furnace than on the other.

The greater weight of checker, however, would also mean a longer time, after the unbalanced condition was detected, before the two sides could again be balanced.

The fluctuation of air temperature during the cycle can be calculated by the method given by Trinks.[7]

[7] W. Trinks, *loc. cit.*, Appendix.

IX. Summary

Conclusions from the study (which has been concerned with heat transfer only and not with strength or durability of checkers) may be summarized thus:

(1) Little is to be gained by the use of different material for the checker brick, except insofar as the substitution would result in a rougher surface.

(2) Large area of heating surface, rather than great weight, is to be desired in a checker.

(3) Considerable improvement can be effected only by decreasing the resistance to heat transfer from the brick surfaces to the air.

(4) The most promising path of development appears at present to be (*a*) in making the brick shapes such as to increase the turbulence, and (*b*) in improving the dust and slag separation so that smaller flues can be used.

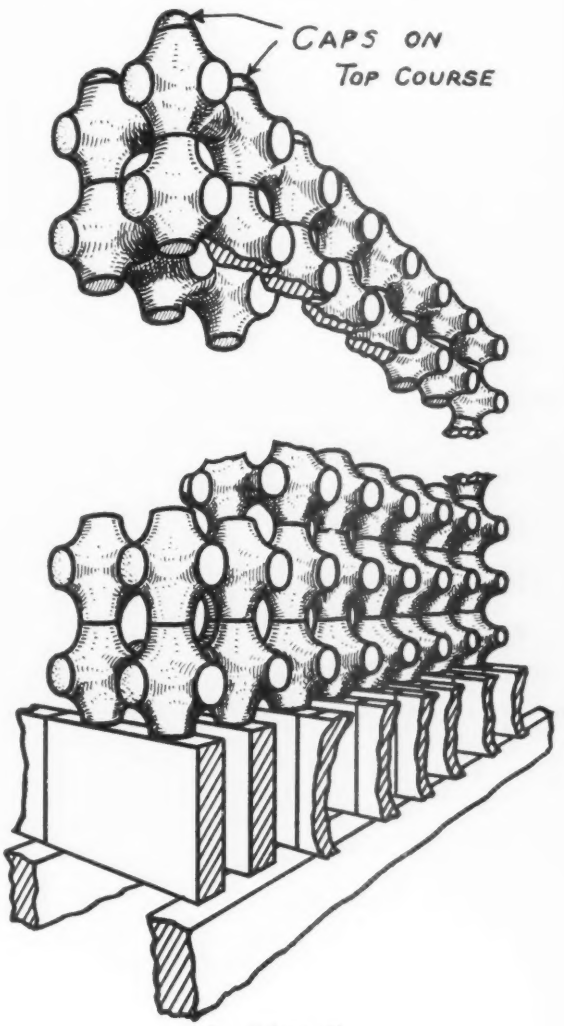


FIG. 7 (part 2).

One outstanding improvement which could be made (and in some plants has been made) does not concern checker brick or setting at all; it is the insulation and sealing of the downtakes and slag pockets in a really effective manner, to reduce the 300 to 400° drop in temperature of the gases which now takes place in most open-hearth furnaces between the ports and the checkers.

The above statements appear to limit quite sharply the possible improvement in heat-transferring capacity of regenerators of the usual type. Looking to the future, however, it is quite possible that a really effective gas-cleaning device will be invented and reduced to practice. With the dust removed from the hot gases before they enter the checkers, the latter can be made of the multipass type with small flues inclosed in casings which are not nominally but actually air-tight, the air and gases being respectively forced and drawn through the checkerwork at several times the highest present velocities by means of fans. The checkers can then be reduced probably to one-third the present size, and the advantages of substituting other materials for fire clay will then become a legitimate subject for consideration.

RESEARCH ENGINEER WITH W. TRINKS
CARNEGIE INSTITUTE OF TECHNOLOGY
PITTSBURGH, PENNSYLVANIA

REFRACTORIES DIVISION FALL MEETING*

Checker Brick and Regenerators

The meeting was called to order by Raymond E. Birch, Harbison-Walker Refractories Company, Chairman of the Division. For the benefit of newcomers he gave a short talk on the organization of the American Ceramic Society and its several Divisions. He stated that there are about 500 members, producers, consumers, and interested technical men, in the Refractories Division. There are three classes of papers presented before meetings of the Division: (1) composition, development, and tests on refractories, (2) processes of manufacture, and (3) consumer's problems.

The third class was represented in this meeting which was concerned with the rôle of the refractory checker brick in heat regenerators. He mentioned briefly the recent improvements in regenerator refractories brought about by process changes including de-airing. A development of major importance for this service, the new class of super-duty fireclay brick, is now being investigated in the glass and steel industries. These brick are attractive because of their greater heat capacity and their greater resistance to load at high temperatures. Improvements in checker brick by increase of density through de-airing and other processes, and the development of super-duty fireclay brick are meeting with favor in the industry because of the greater strength, heat capacity, and less yielding under load.

The two speakers were J. D. Keller,[1] Carnegie Institute of Technology, Pittsburgh, and Wm. C. Buell, Jr., of Cleveland, Consulting Engineer and author of The Open-Hearth Furnace.[2]

* Bedford Springs Hotel, Bedford, Pa., September 4 and 5, 1936. The attendance at the technical session was about sixty-five persons.

[1] For paper by J. D. Keller see p. 144, this issue.

[2] W. C. Buell, Jr., The Open-Hearth Furnace: Its Design, Construction, and Practice, Vol. 1. Penton Publishing Co., Cleveland, Ohio (1936). See also p. 139, this issue.

Discussion on Checker Brick and Regenerators

W. A. TICKNOR, Combustion Engineer, Corning Glass Works, Corning, N. Y.: For efficient heat transfer in a regenerator, the effective heat transfer surface must be large. It is also desirable to have a high gas and air velocity to remove the "dead" film. With a given size of checker brick and checker chamber, greater surface and higher velocities are attained by setting the brick closer and making smaller flues. While the use of large flues avoids danger of clogging by dust, the disadvantage lies in the fact that a larger checker chamber is needed to give the same heating surface. The larger chamber takes more room, costs more, and results in greater radiation heat loss owing to the larger outer surfaces of the whole structure.

In the glass industry, the checkers are subject to considerable corrosion by vapors arising from the batch as it melts. The dust problem may not be so serious as in the open-hearth practice. Generally, in glass-tank practice, the temperature drop from the hot gases to the preheated air is less than 1000°F. The smaller this temperature drop, the greater the regenerative efficiency. An efficient checker setting is very hot on top and is rather cold on the bottom. One checker setting on a large glass tank preheated the air to an average of 2350°F. This temperature was measured by a high-velocity suction pyrometer with the thermocouple shielded against direct radiation.

H. C. SIEBERT, Combustion Engineer, Bethlehem Steel Co., Bethlehem, Pa.: I am in agreement with Mr. Keller's general conclusions. The trend today is toward thin brick, 3 or even $2^1/_2$ inches. Certain calculations on a regenerator with 22,000 square feet heating surface, built of 9- by $4^1/_2$- by 3-inch brick, show that a shell only $^1/_{10}$ inch thick on the brick surface effectively satisfied the heat-exchange requirements of a 100-ton, open-hearth furnace. There is a tremendous heat storage, greatly in excess of the actual use. If a high gas velocity tends to increase heat transfer, just what velocity is best? How much? Maintenance of high gas temperatures on the top

of checker systems requires well-sealed intakes and uptakes. In one test, with gas at 2700 to 2800°F entering the checkers at a velocity of 12 to 17 feet per second (measured at 2600°F), the checkers melted away. The best quality fire brick were destroyed in 40 or 50 heats. This shows that such high entering gas temperatures are not practicable. If first quality fire brick shrink at 2150°F, how can you use them at 2300°? Corrosion by dust and vapors is very serious. We want more refractory brick so that the air may be preheated to 2300°. Large flues lead to longer life but less preheat. Three or four years is the maximum to be expected.

W. H. KELLY, Refractories Engineer, Bethlehem Steel Co., Bethlehem, Pa.: Mr. Keller has shown that a rough surface on the brick increases gas turbulence and better heat interchange. On the other hand, rough surfaces are more likely to collect corrosive dusts. What should be done about this?

R. E. BIRCH, *Chairman:* I believe that 2150° is too low a figure for the softening temperature of the best high heat-duty fireclay brick under load. A better value would be 2250°F for 25 pounds per square inch. The actual load in the regenerator is less than this. Super-duty fireclay brick are much better than is generally realized, and their initial softening temperature under a load is probably nearer 2350° or higher. These temperatures refer of course to long-extended heating on all sides of the brick such as occurs in regenerators but not in many other services.

ARTHUR G. MCKEE, President, Arthur G. McKee & Co., Cleveland, Ohio: In this discussion about open-hearth checkers, I am an outsider, as my principal experience is with hot-blast stoves for blast furnaces. About 2200°F is the maximum temperature. The top checkers will shrink and cause trouble. *The cleaner the gas, the more they shrink.* The infiltration of alkali vapors into the structure of the brick is considerable because the air pressure is 20 pounds per square inch. Dirty gas coats the brick, thus preventing this infiltration, so that the brick shrink less. The ideas of Mr. Keller and of Mr. Buell are well taken. The system must be air-tight and well insulated inside the shell to increase operating efficiency. If the quality of the brick limits the temperature of the air, the problem is for the brickmaker. In the hot stoves for the blast furnace, the maximum temperature is 1800 to 1850°. Conditions are different from the open hearth. The entering air is cold and heats up by passing a long way through small checkers ($1^1/_4$-inch walls). Stack temperatures average around 300°F. Perhaps one might take only part of the open-hearth gases through the checkers and control the whole operation more accurately by having impeller-type, constant-volume pumps for air, fuel gas, and combustion products. Better recovery of dust from blast-furnace gases has been accomplished by better design of dust catchers to slow down the gas velocity. Slag pockets should be redesigned to remove dust, and there should be smaller checkers, higher velocities, and better use of heat-transfer surface. The ideal opening is about $^3/_4$ inch square with $^1/_2$ inch wall thickness, but clean gas is necessary. Short-time reversals are desirable. Blast-furnace practice could be applied to the glass industry if the gas could be cleaned. In the blast-furnace stoves, the efficiency of heat interchange is about 85%, with the loss mainly due to radiation to the variable weather conditions outside.

A. M. CAPPER, Manager, Furnace Division, Continental Roll & Steel Foundry Co., Coraopolis, Pa.: We performed certain tests with a gas velocity of 22 feet per second. It led to a saving of time and fuel amounting to about 12 to 15%. The checkers failed after 30 to 35 heats. The first pass of the checkers had almost completely melted away. What we found we needed was a "super-super" fire brick at the same price as the ordinary fire brick. We could not get this, so we were forced to reduce our gas velocity. To increase radiation from the gas to the brick surface without rise in temperatures, we have introduced "dirt" in the form of free carbon into the gas. We have found some advantages accruing from this method.

J. M. MCKINLEY, Vice-President, North American Refractories Co., Cleveland, Ohio: The past few years have seen great advances in the technology of the open-hearth furnace, particularly in regard to the steel bath itself but, relatively speaking, engineering practice in regenerator systems lags far behind. Our fundamental picture of the open-hearth substructure may have to be expanded. The steel-making capacity of the open hearth has increased with little change in the regenerators. We should surely give more attention to the design and the enlargement of the regenerator system.

FRANCIS C. FLINT, Chief Chemist, Hazel-Atlas Glass Co. (President, American Ceramic Society): In the glass industry, the melting furnace operates for periods of one to two years with little variations in temperature or of rate of glass output. Consequently more time is available to the glass man for control. Conditions are also steadier in the checker-brick system than in steel open-hearth operations. In the glass industry, one finds short uptakes and downtakes and compact regenerators but, nevertheless, very large installations. Alkali dusts and vapor are abundant and very corrosive. Some checkers crust over and close the chambers, requiring a weekly cleaning. The dusts arise from the hot bath in pasty form and are hard to catch in dust chambers. By reacting with the checker brick, these dusts and vapors form a fluid slag, resulting finally in a solid monolithic mass. Sometimes the action of sodium oxide swells the brick. The shape of checkers is unimportant. The big problem is to get a material which is inert to the batch dusts and vapors. Present-day brick are much better than those formerly used, but still better brick are needed.

L. J. TROSTEL, Chief Chemist, General Refractories Co., Baltimore, Md.: It is apparent from the data in the two papers presented as well as from the discussion that the open-hearth operator's regenerator refractory problems are concerned mainly with obtaining brick of increased refractoriness and better resistance to the corrosive action of basic dusts, rather than obtaining brick of greater thermal efficiency.

The fundamental physical and chemical properties of refractory materials are characteristics which we can not change. The melting point, for instance, of certain mixtures of alumina and silica, which we call fire clay, are fixed.

If refractories of higher melting points or better corrosion resistance are desirable, it will be necessary to depart

from the well-known fireclay checker and use products of the sillimanite type or basic brick. The latter are already practiced in numerous glass plants. The refractories producers have been alert in their search for better materials and methods of processing them and have anticipated the future technical requirements of many consuming industries including that of open-hearth regenerator practice.

We also fully appreciate the open-hearth operator's desire to maintain his refractories costs at present levels. The prevailing price of checker brick is largely a function of the use of an abundant raw material, fire clay. If fireclay brick will not continue to do the job in the future and more desirable materials such as those of the sillimanite and basic types are substituted, we must face the fact that these materials are much less abundant than fire clay and initial costs are certain to be higher.

LOUIS A. SMITH, Refractories Engineer, Jones & Laughlin Steel Co., Pittsburgh, Pa. (written discussion): We should have more papers like those of Mr. Keller and Mr. Buell. We should also have papers from the steel producers discussing the abuse of refractories in service.

Mr. Buell says that very few existing open hearths were really designed in the true sense of the word. I am not disposed to disagree with that statement. The inadequacy of preliminary study as well as indifference to fundamentals of good operating practice contribute to a lot of refractories failures which are too often blamed on the brickmaker when the brick user has not done all he should have done. It is easy to ask for better brick, but a great deal of money is to be saved in doing the job better with the materials in hand. The brickmaker can give us better brick but they may cost too much money. I do not say we should not have better brick if we can get them at the right price, but better application of what is already in hand needs just as much of our attention as does the quest for new and better brick.

Statements in this discussion which name 2200°F as the failing point of fire brick do not sound altogether fair to me. Such a statement should carry with it some qualifying remarks as to atmospheric conditions or the presence of corrosive oxides which form low-temperature eutectics when they come in contact with the brick. It is wrong to make a flat general statement that all brick shrink at 2200°F. We know most fire brick are not normally in any distress nor do they show perceptible shrinkage at 2200°F unless there are other than normal air conditions present. We know what reducing atmospheres and iron oxide will do to good brick at 2200°F temperature but we should mention such conditions as contributory causes to the failure of brick at such temperatures as 2200°F.

Mr. MCKEE: I'm Scotch-Irish. In regard to price, I'm all Scotch, but if somebody wants something better for the same price, that is all foolishness.

Mr. BUELL: Mr. Siebert has indicated his belief that refractory quality rather than furnace design and operating practice is the principal factor militating against longer furnace life and lower costs. While I recognize that better refractories, when available, will lengthen campaigns and lower costs, I would remind Mr. Siebert of the great difference in furnace life, as found in different plants. For instance, I know of a plant operating 125-ton furnaces in which the furnace life as recorded over several years is under 150 heats. A few miles away is a second plant, operating furnaces of similar sizes and making similar grades of steel using the same fuel, in which the furnace life is near 300 heats. The same makes of refractories are used in both plants. The rebuilding cost in the first plant is about 60 cents a ton of ingots and 40 cents in the second, both plants having about 70,000 tons annual production per furnace. Most of us familiar with open-hearth operation can recall other similar and parallel plants having greatly differing furnace life.

All operating conditions being reasonably similar, a material decrease in furnace life can develop only as a result of inferior furnace design or operating practice. Refractory quality can be taken as a constant in all similar cases, and the variables found in other factors.

J. D. KELLER (written closure not given at meeting): A large part of the discussion has referred to strength and durability of checkers, and therefore does not require a reply from the present author whose paper was confined to questions of heat transfer. It is desired, however, to answer the specific questions which were asked.

In reply to Mr. Siebert, the average vertical velocity of air in the flues of single pass, open-hearth checkers is usually 0.60 to 1.20 feet per second referred to 60°F. The average velocity of the waste gases is 0.70 to 1.40 feet per second referred to 60°F, which would correspond to between $4^1/_4$ and $8^1/_2$ feet per second actual velocity if the gases entered the checkers at 2600°F. The overall heat-transfer coefficient for the whole checkerwork, as determined from tests on many different open-hearth checkers, ranges from 0.9 to 1.8 B.t.u. per sq. ft. per hour per °F. In no case with which the author is familiar has it exceeded the latter figure, except in secondary checkers where the velocities are higher and flues smaller, or in primary checkers where combustion (after-burning) continues in the checkerwork itself.

For heat transfer, high velocity is desirable, but unless fans are used it is impracticable for reasons which will become clear from the following figures. The total pressure available for moving the air through the checker seldom exceeds 0.35 inch of water. Of this, about 0.24 inch is ordinarily used up by losses at bends and in valves, friction in ducts, and for producing the required velocity in the furnace port; the loss in the actual checkerwork when new is about 0.01 inch, leaving about 0.10 inch as a reserve. When the checker is new and clean, the reserve is absorbed at the valve or air damper. As the checkers become clogged with dust, the air valve is opened wider and the reserve becomes available for overcoming the increased checker resistance. Suppose the checkers had originally been proportioned for a velocity three times as high. The resistance of the checkerwork when new and clean would be then about nine times as great, or 0.09 inch, leaving a reserve of only 0.02 inch. The air valve would have to be nearly wide open from the start and, after a comparatively small number of heats, the dust-clogging would make it impossible to get sufficient air through the checker.

The extremely short life of the brick in the case referred to by Mr. Siebert may be due not only to the high temperature but to excessive carrying-over of dust in addition. As to the question whether high entering temperatures are

practicable with present refractories, it is understood that in many other open hearths of Mr. Siebert's firm the downtakes and slag pockets are insulated and sealed, and yet the life of the checkers is considered satisfactory.

As to Mr. Kelly's question, it is believed that other factors affect adhesion of dust particles to a greater extent than does the surface roughness of the brick. In any case, as soon as the surface is covered with dust, the adhesion of particles arriving later must depend on the dust surface and not on the brick surface, so that after the initial deposit has formed, the rate of growth of the dust layer would be about the same for an initially smooth surface as for an initially rough one. As stated in the paper, the heat-transfer coefficient then is also independent of the original brick surface roughness.

With large-scale roughness as in the shapes of Fig. 9 (as distinguished from surface roughness of the standard brick), it is true that dust would undoubtedly deposit more quickly than in a smooth flue, and the only remedy is periodic cleaning.

HENRY LECHATELIER: I, HIS LIFE AND WORK*

By Alexander Silverman

Abstract

LeChatelier's ancestry, which played an important part in determining his scientific career, is first discussed; then, his education, family, and the family life. The subject matter covered in more than 500 articles which he contributed to various journals is outlined. His books are reviewed. His contributions to practical and theoretical science are covered, including his inventions, namely, the metallurgical microscope and high-temperature pyrometers. Honors which he received are listed. His final interest in social welfare is indicated.

Introduction

In May of 1934, it was the writer's privilege to present a certificate of Honorary Membership in the American Ceramic Society to Henry LeChatelier at his residence, 75, rue Notre-Dame-des-Champs, Paris (6e). Professor LeChatelier had just returned from the IX International Congress of Pure and Applied Chemistry in Madrid, where the honorary degree of Doctor of Science had been conferred upon him by the University of Madrid. Although he was in his eighty-fourth year, this tall, slender, white-haired scholar of France evidenced a clarity of mind which might have been the envy of a young man. While fondling the diploma of the American Ceramic Society in the quaint old parlor, he reminisced about his earlier work. He was fully informed on the latest developments in the fields of chemistry, metallurgy, and glass technology. He had retired from active service, but held the title of Emeritus Minister of Mines of France, and still served as consultant to the ministry. Later, in the old garden with its giant trees, Professor and Madame LeChatelier graciously posed for motion pictures. There was an ever-present look of mutual solicitude on the faces of this interesting old couple.

Ancestry

Henry LeChatelier was born in Paris, October 8, 1850. While there are frequent references to a middle name, Louis, an authoritative autograph which the writer possesses simply reads "H. LeChatelier." His son, François LeChatelier, from whom much of the valuable material which is contained in this article was obtained, also uses the name Henry and not Henry Louis. The official memorial announcement, which was sent to friends by his family, reads "Henry LeChatelier."

Henry LeChatelier's father, Louis LeChatelier (1815–1873), a former student in the École Polytechnique, was Inspector General of Mines for France. He was one of the creators of the French National Railways for whose development he worked from 1855 to 1868. He also served as consulting engineer to bankers who financed the railway systems of Spain, Austria, and Russia. The father had many contacts with eminent scientists, for example, the chemist H. de Sainte-Claire Deville with whom he established the first

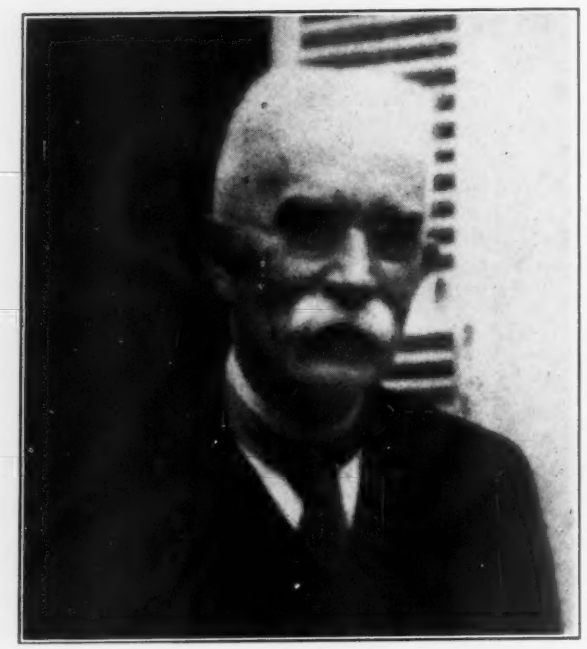
---

* Contribution No. 332 from the Department of Chemistry, University of Pittsburgh, Pittsburgh, Pennsylvania. The library service of Robert Lester Green, Senior Research Scholar, is gratefully acknowledged.

Presented at the Thirty-Ninth Annual Meeting, American Ceramic Society, March 23, 1937, New York, N. Y. (Glass Division). Received January 2, 1937.

aluminum industry of France, and Sir William Siemens with whom he constructed the first open-hearth steel furnace.

LeChatelier's mother, Elisabeth Durand, came from a family of artists and geographers. Among the latter was her great-grand-uncle Buache. One of her brothers was a sculptor and a second, an engraver. His mother was his chief influence up to his fifteenth year. She was an ardent Catholic and a lover of poetry, fostering in her son an appreciation of art which was in evidence when, during his spare moments later in life, he



Henry LeChatelier

visited the galleries of painting and sculpture. LeChatelier devoted himself not only to the scientific literature which was his prime interest, but also to current literary thought, on which he kept fully informed. Though not a musician, he enjoyed music and attended outstanding performances.

LeChatelier claimed that the rigid discipline under which his mother reared her children provided him with an impregnable nervous system and a physical constitution which served him during his arduous labors throughout life. Even when he attended the École Polytechnique, he ate his meals at home at regularly appointed hours. He was taught the importance of rest, would rise early each morning, and then prepare his lessons. After entering the École Polytechnique in 1869, he went to his father's study each morning at 7:30 to review his lessons for the day. He was taught to respect law and order and said that he found the almost military discipline of the École Polytechnique to his liking. He approved the idea of definitely scheduled class periods and of advance notice regarding examinations, which were posted as much as one year ahead.

His grandfather also was a factor in determining Henry's career. It was with this operator of lime kilns that he spent vacations during which his first interest in mortars and cements was undoubtedly aroused.

While he attended the École Polytechnique he assisted his father in receiving visitors. He heard discussions on agriculture, medicine, chemistry, and metallurgy. He observed how his father analyzed and solved problems. The father taught him geometry and had him read essays on chemistry which were submitted by Sainte-Claire Deville, Debray, Dumas, Chevreul. He permitted him to read the reports of the French Academy of Sciences. While the father was creating the aluminum industry, he permitted Henry to assist in studying the applications of the new metal. He took the boy with him to Sainte-Claire Deville's laboratory where the lad heard discussions on chemistry. These helped him greatly in mastering the science and in passing his examinations superlatively at the École Polytechnique. As LeChatelier stated many years later, the contacts which his father arranged for him were largely instrumental in "shaping his career and establishing that reputation which he held as a chemist."

LeChatelier had four brothers and one sister. His brother, Louis, was engaged in bridge and railway engineering and in the construction of steel plants. Another brother, Alfred, an army officer, interested himself in the development of the French colonial empire. In addition, he made a study of high-temperature enamels and these, with his notable collection of pottery, are in the Museum of Decorative Arts in Paris. His brother, George, was an architect who participated in the restoration of many historical monuments. His sister, Marie, married Dr. Henri Leroux who was a pediatrician. The fourth brother, André, worked with Henry, who was the oldest of the children, in creating the autogenous welding industry. He conceived the idea of dissolving acetylene in acetone for the safe stor-

age of liquid acetylene, a practice still followed. Serving as naval military engineer, he made studies on the resistance of metals to high temperatures and designed metal lath, determining its strength in comparison with other materials already in use.

Scholastic Training

As previously stated, Henry LeChatelier was born in Paris in 1850. He obtained his early education in Paris, attended a military academy for one year, later entering the Collège Rollin, where he received the degree of Bachelor of Letters in 1867 and Bachelor of Science in 1868. In 1869 he entered the École Polytechnique. His work there was interrupted by the war of 1870 in which he participated in the defense of Paris. He completed his studies after the war (1872), and registered as a mining engineer like his father. In 1874 he was licensed to practice physical science. He went as geographer to South Algiers where he served until 1877, when he returned to Paris as Professor at the École des Mines.

Collegiate Positions

The rest of his life he spent in Paris, as lecturer in the École Polytechnique (1882), professor in the Collège de France (1883), and then as Professor at the Sorbonne. In 1887 he obtained the degree of Doctor of Physical and Chemical Science and became Professor of Industrial Chemistry and Metallurgy in the École des Mines.

From 1888 to 1897 he devoted himself to the mechanics of chemical reactions, following the studies originated by Berthollet, Sainte-Claire Deville, and Berthelot, establishing the laws of chemical equilibrium and displacement of equilibrium. He also studied solutions. With thermodynamic considerations, he found it possible to determine in advance how reactions should work, instead of hazarding a guess and performing costly experiments which would yield only negative results.

In 1889 he obtained the title Ingénieur en Chef and in 1898 again returned to the Collège de France as Professor of Inorganic Chemistry remaining until 1908. In 1907 he was appointed Professor of General Chemistry of the Faculty of Science of Paris, which title he held until made honorary professor in 1925.

From 1908 to 1922 he directed the researches of more than 100 graduate students of whom 24 obtained doctors' degrees as his majors. As a teacher LeChatelier was a reformer. Instead of providing merely descriptive material and stating facts, a practice generally followed, he introduced the older theories, then the newer ideas, and constantly gave his own interpretation of fundamental principles and laws.

Scientific Researches

In his scientific studies and researches, Henry LeChatelier displayed a remarkable versatility. His outstanding recognition undoubtedly came in the field of thermodynamics and chemical theory. Every student of physical science is familiar with the LeChatelier principle concerning stress and strain and his laws of thermodynamics. The synthesis of ammonia from the elements (1901), in which he anticipated Fritz Haber, was a practical consequence. He interested himself in the study of the allotropy, especially with reference to carbon, silica, and the metals. He made extensive studies of solubility. He was interested in the phenomena of dissociation, both in solution and in gases at high temperatures. He made studies of the combustion of gas mixtures, on the properties and utilization of fuels, and the economics of furnace operation; special studies on carbon, concerning which he wrote an entire volume, and then in the field of explosives as to their general properties and especially their utilization in mining.

In metallurgy, while he was interested in the general field, he devoted himself more particularly to the production and properties of iron and steel. He applied the phase rule of Willard Gibbs and devised simple proofs. In fact, without LeChatelier's principle of mobile equilibrium, Gibbs' rule and phase-law diagrams which we prize might not have had the practical value which they now possess. He invented a metallographic microscope by means of which he was able to study and photograph crystals which formed in alloys, principally iron and steel, where he investigated the compounds of iron with carbon, and studied heat treatment.

In his various researches on combustion and metallurgy, it was necessary to measure high temperatures. Instruments already in existence were inaccurate beyond 400 or 500°C. He was compelled to devise an accurate high-temperature pyrometer, and this led to his adoption of the

platinum platinum-rhodium thermocouple, as gas thermometers would not serve.

Ceramic Work

Members of the American Ceramic Society are particularly interested in his contributions to ceramics. These are covered in numerous publications on mortars and cements, clay, silica, and the silicates. Methods which he devised for determining coefficient of expansion and electrical conductivity of various materials were among the first available.

His various investigations resulted in the publication, since 1874, of more than 500 articles in pure and applied science. They include references to numerous biographical sketches of eminent scientists.

Books Published

High-Temperature Measurement

LeChatelier wrote a number of books. His first published volume, though not the first which was written by him, was Mesure des Températures Élevés (The Measurement of High Temperatures) which appeared in Paris in 1900 with the joint authorship of O. Boudouard. The two authors had already prepared a summary of work in this field in 1898. The volume has had numerous translations and revisions. In 1912, The Measurement of High Temperatures by G. K. Burgess and H. LeChatelier appeared in New York. This work was certainly of paramount importance, for it was the first extensive compilation of principles and methods for high-temperature measurements.

Already in 1885 LeChatelier had indicated faults in the older thermocouples of Becquerel and Pouillet. He states,

> When I attacked the problem of measurement of high temperatures, it is fair to say that there existed nothing definite available on this important question; we possess only qualitative observations for temperatures above 500 °C.

LeChatelier discarded iron, nickel, and palladium in favor of platinum platinum-rhodium couples.

He introduced galvanometers of high resistance and recommended the calibration of thermocouples against the melting points and boiling points of pure substances instead of against air thermometers. He developed an optical pyrometer and calibrated it by comparison with a thermocouple. In the use of these instruments in the laboratory and in industry, he corrected erroneous data which already existed, sometimes changing the temperatures by several hundred degrees. Then he graciously admits the important contributions of Burgess, who conducted independent investigations, and praises him in the highest of terms. The book is too well known to ceramists to require elaboration.

Cements

Essais de Matériaux Hydrauliques appeared in Paris in 1903. In this volume LeChatelier discussed lime and hydraulic cements, their classification; the mechanism of hardening; qualities displayed while in use; physical testing; chemical analysis; preparation of experimental mortars; influence of air, water, and salt solutions; mechanical resistance displayed at various stages; the possibility of securing unchangeability in volume and composition. The volume was translated by Joseph L. Mack and appeared in New York in 1905 under the title, Experimental Researches on the Constitution of Hydraulic Mortars.

LeChatelier's volume on hydraulic mortars already had its beginning in his thesis for the Doctor of Science degree in 1887. As he states himself, this was the beginning of fifteen years of study of the subject. He was amazed that, when Mack offered to translate the volume, it could still possess sufficient interest to merit reprinting, because of the time which had elapsed since the beginning of the researches. He did not have time to bring the volume up to date, but indicated in notes the most important advances on theoretical knowledge of cements, giving references for the articles. He felt gratified that, in a country like the United States where great advances had been made, men should still take an interest in his researches. This classic investigation, as stated by the translator in 1905, "stands today as the first and most complete and beautiful piece of work done upon the chemistry of Portland cement." The American translation supplemented the original work with discussions of silicates, aluminates, and ferrites of calcium; barium silicate, barium cements, and microchemical examination.

Carbon

Leçons sur le Carbone (Lessons on Carbon) was published in Paris in 1908. It seems that, during

his lectures on carbon at the Sorbonne in the years 1907 and 1908, his pupils requested the publication of his talks. He regrets that the volume was premature and that he did not have time to check over his data. This modesty crops up time and again in the preface to LeChatelier's works. The preface to this volume makes rather a fine distinction between physics and chemistry:

> To understand the necessity of profoundly changing the modes of instruction of chemistry, it suffices to compare a course in chemistry and a course in physics. These two sciences have a common objective; they both study all the phenomena giving rise to transformations of energy... In the teaching of physics one speaks of natural phenomena through the various laws which interpret them, but the particular properties of the different bodies are passed in silence. One considers physical traits in the abstract, and experimental determinations are reduced to measurements which serve to establish the laws. In a word, the teaching of physics is exclusively scientific. In chemistry on the contrary there is an infinite enumeration of small particular facts: formulas, physical properties, reactions, methods of preparation and analysis, and, ultimately, possibly manufacture itself. The results accumulated are useful in further establishing chemical science, but do not entirely constitute the science in themselves.

The lectures covered in the volume on carbon include one on Sainte-Claire Deville and Moissan, followed by others on physical properties of carbon; chemical properties; the general subject of combustion; absorption; allotropy; metallic carbon (graphite); carbonic acid and metallic carbonates; the oxides of carbon; the combustion of mixed gases; the origin of coal; the laws of mechanics; important laws of chemistry; atomic and molecular weights and, finally, the experimental determination of molecular weights. This volume clearly indicates LeChatelier's attitude. He is willing to introduce practical matters, but is insistent about the importance of fundamental laws and theories.

Metallurgy

Introduction à l'Étude de la Metallurgie—Le Chauffage Industriel (An Introduction to the Study of Metallurgy—Industrial Heating) appeared in Paris in 1912. It was translated into German in 1920 by B. Finkelstein. The original French edition has also been revised. There are two divisions to the book. Under heating, LeChatelier discusses the phenomena of combustion; the combustion of natural solid fuels like wood and oil, the artificial fuels, charcoal and coke; acetylene, water gas, coal gas, producer gas. Part I closes with a consideration of refractory materials and furnaces. In Part II, on metallurgy, he discusses microscopy and metallography, changes of state, physical equilibria, the constitution and heterogeneity of alloys, and the tendency toward intermetallic compound formation.

Silicates

La Silice et Les Silicates (Silica and the Silicates) was published in Paris in 1914. In this monumental work, LeChatelier discusses the occurrence of silica and the silicates; chemical properties of silicon oxides, namely, their various reactions with other substances; hydrated silica; amorphous silica; crystallization of quartz and physical properties of various forms; polarization; refraction studies. In the section on glass, he considers general properties; chemical properties of both massive and pulverized glass; physical properties, including expansion and optical properties; the metallic silicates, and their classification. He even goes into the subject of constitution and crystal nature of compounds in glass, though naturally from an empirical standpoint, as X-ray analysis was not yet practiced.

Science and Industry

In 1925 Paris saw the appearance of Science et Industrie (Science and Industry). The volume starts with a definition of science, contains an outline of general principles, and then takes up the importance of observing facts, making experimental measurements, avoiding errors, reasoning soundly, applying the laws of science. Then comes the industrial origin of science, the influence of science on industry, the introduction of science into the plant, a discussion of discovery and invention. Finally, LeChatelier tells how scientific instruction should be given, how technical instruction along special lines should follow, and then closes with the "Taylor System" of organized management and production, which he greatly admired and wanted to see applied in France.

As in his journal articles, the exact scientific trend of LeChatelier's mind is in constant evidence in his books. They are illustrated where necessary, but not superfluously; his translators are more generous in this respect than is the author himself.

Promoted Industrial Research

LeChatelier's linking of science with industry and especially with national defense was already in evidence in the spring of 1916, while France was in the throes of combat. He addressed the Academy of Sciences:

> Public opinion is concerned with the eventual rôle of science in the reparation of ruins accumulated in the war. In disinteresting itself from this task, will not the Academy of Sciences fail in one of its most imperative duties? Without pretending to enter into details of application, strange to its competency, would it not be able usefully to give indications of methods of work appropriate for the economic relief of France? The scientific method has for a long time proved its ability in development of recognized theories; it should likewise serve through the dissemination of knowledge practically indispensable to public well-being.

In this connection he spoke of the failure of industry and national officials to sponsor scientific investigation like that of Germany, Great Britain, and the United States. He cited the progress of laboratories in those countries and deplored the lack of French patronage of its own institutions, for example, the Pasteur Institute. He continued,

> The chief error has been to reduce science to the collection of facts, of laws, namely, the results of science. However, with the great number of problems rising in industry, very few of these results have been utilized. I claim that there is a real usefulness in scientific study.... The methods of physical science are experimental. They are acquired in the laboratory, not at the blackboard. The possible wider use of the laboratory in our various establishments, universities, and industries, should be our dominant preoccupation.

This forceful attack had a salutary effect. France has applied science in a larger measure for the public weal, for industrial advancement, and for national defense. It was undoubtedly this attitude of LeChatelier's which caused Woodrow Wilson to consult him in an advisory capacity when our own National Research Council was established in 1916 on the recommendation of the National Academy of Sciences.

Member of National Commissions

Though LeChatelier had been a member of the French National Commission on Explosives (1902), the National Science Bureau (1913), and a permanent member of the Commission on Weights and Measures since that year, he was, in 1917, on the strength of his address before the Academy of Sciences, made a member of the Commission for the Standardization of Metallic Products. That same year he was placed on the Commission for Specifying Standards for Materials of Construction Other than Wood; eventually, this led to a permanent commission for the standardization of all products. In 1919 we find him a member of the National Commission on Inventions. In 1922 he succeeded Lemoine on the Commission for the Control of the French Monetary Circulation.

Scientific Societies, Activities, and Honors

LeChatelier represented France at international meetings. He was a delegate to the Seventh International Congress of Pure and Applied Chemistry, London (1909); the Eighth International Congress of Pure and Applied Chemistry, Washington (1912); and the Ninth International Congress of Pure and Applied Chemistry, Madrid (1934).

It is interesting to note that, although LeChatelier received the Jerome Ponti prize of the French Academy of Sciences in 1892 and the Lacaze Prize in 1895, his election to the Academy resulted only after five nominations. This is not strange when one considers the opposition which has been offered repeatedly to the admission of men of eminence, for example, Louis Pasteur. LeChatelier was nominated in 1893 on the death of Fremy; again, in 1897, on the death of Schutzemberger; a third time in 1898, to take the place of Friedel; the fourth time, in 1900, to replace Gumaux. He was finally elected in 1907 to replace Moissan, on the latter's death.

LeChatelier was a member of many important committees and an officer in various societies in France. He was Vice-President of the Mineralogical Society and Vice-President of the Chemical Society (1897); President of the Mineralogical Society (1898 and again in 1910); President of the Society for the Encouragement of National Industry (1904); President of the French Physical Society (1907); member of the Science Council of the Central Society of French Architects (1909); honorary member of the Association for Bibliographic Documentation (1913). In 1922 he became Honorary President of the Chemical Society of France, Honorary Administrator of the Society of Mineral Industry, Honorary Councilor of the Society for the Encouragement of National industry, an honorary member of the Committee for French National Organization, an honorary member of the Technical Foundry-

men's Association, and an honorary member of the Society of Civil Engineers of France.

Henry LeChatelier received a number of decorations. In 1886 he was made a chevalier of the Legion of Honor; in 1908 an officer, in 1919 commander, and in 1927 grand officer. In 1906 he became a knight of the Order of St. Anne of Russia, and in 1928 a chevalier of the Order of the New Republic of Poland.

He was awarded many prizes and medals for his contributions to science and industry. In 1900 the Minister of Commerce awarded him the Grand Prize of the Paris Exposition; in 1908, the Société de l'Industrie Minérale gave him the Medal of Honor. In 1928 the Minister of Public Works presented him with the Medaille d'or (gold medal) des Ponts et Chaussées. He received the Grand Prize of the International Exposition in St. Louis, U. S. A. (1904); the diploma of honor of the International Exposition in Liége, Belgium (1905); the Grand Prize of the International Exposition in Milan, Italy (1906); the Grand Prize of the International Exposition in Brussels, Belgium, the Grand Prize of the Franco-British Exposition and the Bessemer Gold Medal of the Iron and Steel Institute, London (1910); the Grand Prize of the International Exposition of Industries and Manufactures, Turin, Italy (1911); the Davy Medal of the Royal Society, London (1916); and the medal of the Association of Engineers in Liége, Belgium (1932).

Many foreign societies elected him to honorary memberships which follow: Imperial Technical Society, Russia (1901); Royal Institution, Great Britain (1904); American Institute of Mining and Metallurgical Engineers (1905); Society of Arts and Sciences, Roumania (1908); Deutsche Chemische Gesellschaft, and Society of Physics, Spain (1909); Metallurgical Society, Russia (1911); Scientific Society of Brussels, Belgium (1912); Institute of Structural Engineers, London, Society of Glass Technology, Sheffield, and Ceramic Society, Stoke-on-Trent (1913); Chemical Society, Argentina (1914); Institution of Mining and Metallurgy, and Council of Institute of Metals, London (1917); American Academy of Arts and Sciences (1919); Association of Engineers, University of Liége, and Royal Irish Academy of Sciences, Dublin (1920); American Society of Metals, and Chemists' Club of New York (1921); Chemical Society of Poland, and Honorary Vice-President Iron and Steel Institute, London (1924); Society of Physical and Chemical Science, and Academy of Sciences, Russia (1926); Academy of Sciences, U.S.S.R., and American Society of Mechanical Engineers (1927); Chemical Society of the Netherlands, and Institute of Scientific Organization, Poland (1928); American Ceramic Society (1934).

Honorary Degrees

Honorary Doctor's degrees were conferred upon him as follows: Doctor of Engineering, Königl. Technische Hochschule of Aix la Chapelle, Germany (1910); Doctor of Science, Victoria University of Manchester, England (1920); Doctor of Technical Science, Polytechnique Institute, Copenhagen, Denmark (1921); Doctor of Science, University of Louvain, Belgium (1927); and Doctor of Science, the University of Madrid, Spain (1934).

His Family

On May 29, 1876, Henry LeChatelier married Genevieve Nicolas, whom he had known since childhood; in fact, his father and Miss Nicolas' father had been chums in the École Polytechnique where they both studied as engineers. There were seven children by this marriage, three boys and four girls. Charles, the oldest, is a mining engineer; the next, a daughter, is Mme. René Chaudesris, whose husband is an engineer of arts and manufactures and an officer of the Legion of Honor. The third, Mme. Jean Royer, married an engineer of arts and manufactures, also chevalier of the Legion of Honor. She coöperated with her father after her marriage, especially at the time when the *Revue de Metallurgie* was established. The fourth, Mme. André Lemaitre, married an agricultural engineer. The fifth, Louis LeChatelier, is an engineer of arts and manufactures. The sixth, Mme. Émile Bernier, married a naval engineer. The youngest child is François LeChatelier, mining engineer and a chevalier of the Legion of Honor, whose cooperation in the preparation of this article has already been acknowledged.

In June, 1936, M. and Mme. LeChatelier celebrated their sixtieth wedding anniversary surrounded by their children, their thirty-four grandchildren, and their six great-grandchildren.

LeChatelier devoted all of his spare time to his family. He played with the children, would take them on excursions on Sundays and during

vacations. He particularly interested himself in their studies and later in the studies of his grandchildren. In the spring of 1936 he went to Miribel-les-échelles with his grandchildren to give them a review in chemistry and physics. On the eve of his death, disregarding his fatigue, he dictated to one of his children advice concerning the study of descriptive geometry for the help of one of the grandchildren who was having difficulty with this subject.

Professor LeChatelier would not have been able to follow his career with the responsibility of his large family and other difficulties, notably, political interference, had it not been for the devotion and self-abnegation of Mme. LeChatelier. She devoted herself to the life and education of her children and to making it as easy as possible for her husband to continue his career. She indirectly played an important part in this brilliant career.

Henry Le Chatelier Foundation

On January 22, 1922, the French Academy of Sciences celebrated the fiftieth anniversary of his graduation from the École Polytechnique and presented him with a bronze medal, prepared by the eminent sculptor, Lamourdedieu. Toward the close of 1921, subscriptions had accumulated through the sale of these medals which, after defraying all expenses, left a net fund of 100,000 francs. This was presented to the Academy of Sciences to honor LeChatelier and its utilization was to be under his direction. In other words, the Academy established the Henry LeChatelier Foundation. There were many addresses in which his accomplishments were reviewed and in which he was given high praise and commendation.

His Philosophy

At the close of his address of acknowledgment and acceptance, he stressed the importance of discipline, to which reference has already been made in earlier sections of this article concerning the influence of his parents on his career. He attributed his success, or that measure in which he had been successful, to the discipline of childhood and of educational institutions which he attended. He stressed the necessity for clear thinking, verified by exact experiments. He told how Schutzemberger had jeopardized his reputation when he tried to invalidate the law of definite proportions in an experiment in which carbon dioxide diffused through the long rubber connections of the apparatus without Schutzemberger's detection of the loss. He mentioned Sir William Ramsey and his announcement of the transmutation of copper into lithium and carbon, which discovery was later proclaimed false, as the carbon had come from the stop-cock lubricant and the lithium from the glass. What LeChatelier condemned in these two examples which he cited was the lack of careful experimentation.

He deplored decreasing seriousness of study and an increasing tendency toward pleasure and even license in modern colleges and universities. He likened the irresponsible student to a bold individual who dodges vehicles in crossing a street and risks being crushed, to say nothing of the fact that he seriously ties up traffic. To the young chemist he recommended modesty, with a reluctance to overthrow the findings of the past until he has proof positive. "One makes discoveries if he can and not merely through the wish to make them."

LeChatelier placed integrity above all else. On one occasion he was approached by a politician after he had received an honor and was asked to favor a particular faction or cause. He replied, "I have never sought an honor, and I, therefore, assume that when it was conferred it was mine without obligation." On frequent occasions he might have enjoyed promotion or honors by granting favors or acquiescing in matters with which he was not in accord. He lost his chair in the École Polytechnique because of conscientious differences with Wurtz concerning atomic theory.

Shortly before his death, as president of the International Congress of Mines and Metallurgy and of Applied Geology, LeChatelier lamented the fact that not enough attention was being paid to social progress. He prepared an article entitled "Morals and Human Affairs," corrected it while lying on his death bed, and insisted, repeatedly, that it be sent to the "Bulletin de l'Union sociale des Ingénieurs Catholiques" (The Bulletin of the Social Union of Catholic Engineers). The article appeared posthumously in December, 1936.

His Death

Since 1935 LeChatelier had suffered at times from angina pectoris. He was incapacitated several days before his death by a particularly violent attack to which his heart, enfeebled with

age, could not respond. He died peacefully, unconscious of his suffering, on September 17, 1936, at his country estate, Miribel-les-échelles (Isère), France, in his eighty-sixth year.

Perhaps the author's tribute, which follows, will in a small measure, summarize the life of this noble being.

Father studied of Earth's minerals,
Father's father burnt its lime,
Mother's forebears mapped world nations,
She herself was soul sublime.

Thus, the Son, one born of Genius,
Nurtured by the Mother's care,
Guided by the Father's wisdom,
Must find interest everywhere.

And he did, in Natural Science,
Striving morning, noon, and night,
Wrest from Earth some of her secrets,
Set them forth, as well he might.

First the gross, the coarser findings,
Then with microscope, the small,
Next the laws, their explanation
Gave this Savant, slim and tall,

Always striving, earnest, modest,
More to learn and more to give.
Discipline, his life, his motto,
Showing others how to live,

Not for pleasure, not for glamour,
But to serve both Man and State.
In this service helped a woman,
That self-sacrificing mate,

Who with patience him encouraged,
Bore him sons and daughters rare.
These love art and science also,
Further lay Earth's secrets bare.

Nations far and wide our Scholar
Honored in their Guilds, and then
Made him of their Groups a member;
Always happy, where and when

He would visit, in his travels
Their great scholars, more to learn;
Learn, but giving more than taking,
Adding to Minerva's urn.

Flames he measured, as to hotness,
Even solar heat, so high.
Glasses made he in the furnace,
Products pleasing to the eye.

But his sunset saw the smoulder
In his fellow worker's breast,
Which portraying surface under,
Showed a feeling of unrest,

Showed that some had blessings many,
Others few. These torn with strife
Often suffered untold tortures,
Trudging through the walk of Life.

Thus, on death-bed, leaving Science,
He espoused the Public weal,
Pleading strong the Cause of Justice,
Signing with his last Earth-Seal.

May his message bear fruition,
Lift from Life its shaded hood,
Make men see that Life's worth living,
Holding hope, and boding good.

Gone our Savant. Yes, in body;
Not in mind or soul, for they
Will abide with us forever.
They'll live Aeons, no mere day.

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF PITTSBURGH
PITTSBURGH, PENNSYLVANIA

ACTIVITIES OF THE SOCIETY

PRESIDENTIAL ADDRESS*

By Francis C. Flint

Introduction

The American Ceramic Society is thirty-nine years old today. Its beginning was small, but, like every good work, it grew because the seriousness of purpose was there and the men behind it were true. Many a similar organization has started and failed. Many a problem has been taken up only to die for want of the proper men to handle it.

The American Ceramic Society has grown through the years, occasionally changing its color, sometimes appearing more successful than others, but always moving forward. No one man has done this, nor one group of men. Oftentimes the progress that is made in one particular year is based on the broad-gage decisions of several years before, and in the last eighteen years, through all the comings and goings of administrations and committees, the constant thread of Ross Purdy's influence has been with us—sometimes agressively, sometimes in the background, but always unselfishly for the development of the American Ceramic Society and its own good he is unselfishly working for the benefit of the science and industry it serves.

I shall not give you a list of this year's accomplishments but shall try to show the progress we have made continuously along certain lines, remembering that our Constitution calls for the promotion of "the ceramic arts and sciences by holding meetings for the reading and discussion of papers, by the publication of literature, and by such other activities as are authorized by the Charter of this corporation."

Educational Program

As an example, for many years there has been going on a round-robin of discussion on the education of the ceramist. This had been actively worked on ever since very nearly the beginning of the Society. The discussions have finally come somewhat to a head this year in a manner that I believe will clarify our definitions and aims and move on to the next milestone of the development of better men to serve in the production of ceramic ware.

The Education Committee, under H. E. White, has done an outstanding job. Through him we have coordinated one branch of our endeavor by coördinating with the other engineering societies. Most of the detail of this you will see in *The Bulletin*.[1] You will not, however, be able to get in that printed report the fine spirit of cooperation that this has called for, the work Keramos and A. F. Greaves-Walker did, the meetings with the Education Committee of the university professors and the background of study by other members of the Committee.

This was no new work. If you will look back to Emerson Poste's time you will find it actively coming to a head. It made further progress the following years under J. C. Hostetter and W. Keith McAfee, and finally J. M. McKinley put a great deal of time and thought on it.

Tied in with this work of the development of the educational program of the Society are several very serious aspects. The education of engineers in the United States is moving forward at a rapid pace. All of the engineering societies and schools are developing more advanced curricula. The basis of the education of the ceramic engineer must be kept in pace with them if we are to maintain our status with them.

Along with this comes the larger problem of the new attitude of registering professional engineers by the states. This is being aggressively handled by the other engineering societies and we will coördinate with them.

With this has come another problem in which we, in a more restricted field than some of the other engineering societies, either in respect of numbers or in angles of attack, can very quickly get ourselves classified as a special sub-branch. Our aggressiveness and the background of work we have done with them is giving our engineers more of the fellowship which the situation requires. This has struck deeply into the Society.

You will recall that last year when we wrote the Constitution we did so entirely with the idea that we would make it up to date and legal and without making many major changes in the set-up. Immediately this condition calls for amendments giving special status to the engineers, not as an internal working force in the organization but to allow them as engineering individuals and as a group to coördinate with the engineering societies. In doing so, provision is being made for a similar set-up with the technologists and the artists, though at present there is no particular need of their definitely being organized.

However, the professional technologist is beginning to look into the matter of his own registration and protection against the inclusion of technicians who are not professionally trained. There is a vast difference in mental attitude and in the type work which is beginning to be recognized.

Research Committee

With this work along technical lines, the Society's contact with other organizations is becoming slowly more thorough and continuous. The Research Committee this year added to its burdens by taking on the contacting of other organizations for symposia and meetings in conjunction with other scientific and technical societies. The

---

* Presented at the Thirty-Ninth Annual Meeting, American Ceramic Society, New York, N. Y., March 22, 1937 (General Session).

[1] H. E. White, "Report of Committee on Ceramic Education for 1936," *Bull. Amer. Ceram. Soc.*, **16** [3] 111–20 (1937).

continuous contact between the various Divisions of the Society with outside groups will accomplish the two-fold purpose of giving us a broader viewpoint and at the same time developing the knowledge of our background and those with whom we meet.

This year the meeting between the Materials and Equipment Division and the Non-Metallic Division of the American Institute of Mining and Metallurgical Engineers, the meetings of the Art Division with the craft teachers, a very successful meeting of a goodly number of the Glass Division at the International Congress in London have been examples of this.

Student Branches and Local Sections

One of the backgrounds of the growth of the Society, like all organizations of this type, is its Student Branches and the Local Section meetings. Emerson Poste has done an outstanding job this year in coördinating the Student Branches and encouraging and working with the Local Sections. I myself have attended a number of the meetings and was more than delighted not only with the quality of the meetings but the enthusiasm shown. I wish very much that every incoming President would find himself able to attend as many as possible of these meetings in order to give during the year the contact between the officers and the local members, a continuity which our Annual Meetings cannot do. The personal contact is worth as much as anything that may be said, for after all the spirit of the affair, including our Annual Meeting, is seriously necessary. All of us come to our Meetings, as we do to any other technical society, mainly for the purpose of shaking hands and breaking bread with those whom we meet only occasionally or whose articles we read during the year.

Scientific and Technical or Trade Association

We have, in the past, given very serious thought to the set-up of the Society—our functional and product divisions and our attitude as a scientific, technical, or trade association. This has been developed in detail by a number of the other presidents. Most of us realize and appreciate that we can not do both types of work with success. Our foundation was technical and scientific. The breadth of our abilities has been backed up very much by those who are not specifically trained as our leaders. Our growth is very definitely following the old channels in which science is making the tools for the technologist and the technologist is using them in the manufacture of more and better and cheaper products and, though we do not intend to hide our light under a bushel, the sales and advertising advantages could well be handled by men in the corporations which are helping to support the Society but who are organized in other ways to handle it.

General Sessions

J. C. Hostetter brought out the complexity of our meetings and several of the other presidents have felt, after their experience, that more could be done at our general sessions. Not much progress has been made this year on this particular subject, though I believe in the future we could work back up to fundamentals of ceramic technology and science, which are valuable to most of the Divisions, and carry on more general meetings. Against it is the fact that a general meeting is pretty large for discussion. But it is the fact that the one common bond of interest between the Divisions is these fundamental, scientific problems which should not be given only to one of the particular Divisions in which a man happens to be working.

We do have more than the usual number of speakers at this Session, some of them men who have worked accidentally in one group, but whose work is really for all of us—for example, Dr. Morey's efforts. It is for the purpose of having these speakers that the general sessions are worth while.

Materials and Equipment Division

Along this line I have a feeling that the Materials and Equipment Division, though this is probably the best year it has ever had, is standing to one side when a good many of the men would be valuable members of the other Divisions, the value being not only to the Divisions in having those men's activities but to the material and equipment men who would be associated with those whom they come to see at the Meeting.

Summer Meetings

This year has seen us set more firmly in the habit of Summer Meetings by the Divisions. The Materials and Equipment, Art, White Wares, Refractories, and Glass—five Divisions—have held very successful summer meetings—all so successful that we may look on them as a permanent part of our organization life.

Summer General Meetings

With the growing prosperity in business, which is a very necessary factor of our background, we may find the ability to hold general annual trips coming to the fore. This year Ross Purdy made a trip for the Society to California, which was successful far beyond the dreams of the Board, who sent him. Out of this and the growing industrial activities in the South and our increasing contacts with Canada should come summer trips for members of the Society which should be as memorable as the last one we made in 1926, which gave us our theme song, "Alouette."

Financial Condition

No organization can exist successfully without a satisfactory financial background. The Society has passed through its most serious depression with unusual success. Thanks are due primarily to Ross Purdy, who, in spite of complaints on all sides, cut here and there, still saving for us *The Journal* and *The Bulletin* in good shape; and officers of the Society during the depression worked as few men have done before. We are definitely on the up-grade, and I strongly urge that the Society build up again and maintain the reserve which Ross Purdy's foresight gave us to tide us over those trying times.

Finance Committee

We have this year, as a part of the Board, set up a Finance Committee composed of three men who are assisting in the guidance of the Ceramic Society's funds and helping to determine the practicality of our policies.

Conclusion

We are nearly forty years old as an organization. Our industry is amongst the oldest in which mankind has in-

dulged, older than textiles, older than the vast chemical industries which dot the world today. The permanence in value is attested by the fact that we are now finding evidences of its beginning after thousands of years. During most of that time it made halting steps forward, almost one at a time. The last generation has seen an acceleration of pace in the advancement both in engineering and technology that has astonished us. We are now producing for everyone of our people articles that formerly were reserved for the very restricted few in ancient days. We are giving them better products and cheaper ones. We are fitting into the developments of modern machinery and keeping pace. It is ours to carry on abreast of the efforts of other endeavorers, not only in the all-important technology, but in the machine and engineering developments of the day and the artistic application of these advances.

HAZEL-ATLAS GLASS COMPANY
ZANESVILLE, OHIO

INDUCTION CEREMONY FOR OFFICERS OF THE SOCIETY FOR 1937–38*

BY ALEXANDER SILVERMAN

Gentlemen, you are about to be inducted as officers of the American Ceramic Society. Men become truly great only through the use of their faculties in behalf of their fellow men. Great abilities devoted to selfish or personal ends may gain wealth, power, rank, adulation, but in the end these turn to dust, leaving behind only a fleeting memory.

Organizations are like men. They are built of human units, and like these units they are bound by the same immutable laws. They become great by service, and by service only. Insofar as they reflect the high and noble ideals of their members, they grow in influence and prestige.

The American Ceramic Society was founded and has been carried on these many years in the spirit of high purpose, to add to human knowledge, to promote acquaintance, to break down the barriers of a narrow, self-defeating secrecy, and to substitute in its place friendly coöperation, all for the greater good and glory of mankind.

You who are about to assume the direction of the affairs of this Society are greatly favored men, not because of the honor that has been conferred upon you, but because of the opportunity that is yours. You have the great responsibility of carrying forward the noble traditions of this Society. You are blessed above others in that your fellow members have selected you as the fitting representatives of this body to carry on these traditions.

You have been selected in the legal and constitutional manner to take over the fortunes and guide the destinies of this great Society. In one sense your task is easier than was that of your forebears, because your field is now better defined and crystallized in the popular mind than it was. In another sense, it is more difficult, for the American Ceramic Society has thousands of members. It is matter of national concern that the affairs of this Society be well directed. It did not matter so much what the original twenty-two members said, or thought; they had no national status; but what the present membership says and does is a matter of national concern.

May I presume to say to you that there is but one key that will unlock the doors to all the difficulties that will confront you, and that key is the one which was forged by our founders, namely, idealistic service: your unselfish desire to serve industry, to serve your country, and, generally, to serve your fellow men. I believe that this is a worthy cause. I shall now read the induction pledge:

"The thing which marks one group of men as better than another is not their wealth, their culture, their skill. It is their spirit of coöperation, the ability and willingness to pool their energies unselfishly in the cause of human advancement. Recognizing the truth of this principle, do you now, in assuming the leadership of the serious group of American scientists, technologists, and industrialists, accept your respective offices as a sacred trust, and consecrate yourselves anew through service to this organization, to the broader service of mankind?"

The Officers-Elect: I do.

Inducting Official: In virtue of the authority temporarily vested in me, I pronounce you gentlemen duly qualified as elected officers of this Association, and I extend the right hand of fellowship.

* Induction of officers of the American Ceramic Society for 1937–38 was held at the Waldorf-Astoria Hotel, Tuesday evening, March 23, 1937.

OFFICERS INDUCTED AT THE 39th ANNUAL MEETING

President: Robert B. Sosman, U. S. Steel Corp., Research Laboratory, Lincoln Highway, Kearny, N. J.

Vice-President: Victor V. Kelsey, Consolidated Feldspar Co., Trenton Trust Bldg., Trenton, N. J.

Treasurer: C. Forest Tefft, Claycraft Company, Columbus, Ohio.

Trustees of the Industrial Divisions

Art: L. E. Barringer, General Electric Co., Schenectady, N. Y.

Enamel: H. G. Wolfram, Porcelain Enamel & Manufacturing Co., Baltimore, Md.

Refractories: C. E. Bales, Ironton Fire Brick Co., Ironton, Ohio.

CELO KYANITE
UNIFORM QUALITY DEPENDABLE SUPPLY
FOR INFORMATION AND SAMPLES WRITE TO
CELO MINES, INCORPORATED
BURNSVILLE, NORTH CAROLINA

Robert B. Sosman, President 1937–38

Victor V. Kelsey, Vice-President

C. Forrest Tefft, Treasurer

Cecil E. Bales, Refractories Division Trustee

L. E. Barringer, Art Division Trustee

H. G. Wolfram, Enamel Division Trustee

MAKE PLANS FOR THE 1938 (40TH) ANNUAL MEETING IN NEW ORLEANS

THE EDUCATIONAL TRAINING AND EMPLOYMENT STATUS OF MEMBERS OF THE AMERICAN CERAMIC SOCIETY

By E. E. Marbaker

The Committee on Ceramic Education has been making a study of the curricula offered by leading universities for the training of prospective ceramists and ceramic engineers. In order to arrive at a sound basis for comparison and for constructive suggestions, it seemed desirable to learn something of the training of the men already engaged in these professions, to determine what proportion of the membership had received ceramic training and, if possible, to evaluate its importance in comparison with that of more general types of education.

Until recently the records of the members of the group of Fellows constituted the only source of information available to the Committee. These data were tabulated although it was evident that the group was too small in comparison with the total membership of the Society for valid statistical generalizations. In order to obtain information concerning the training of a much larger section of the Society, a questionnaire was sent to all the members except the Fellows. The return amounted to somewhat less than 50%, but it was thought that this number was sufficiently large to warrant tabulation and analysis.

The results of the study were compiled in tabular form in which the data were presented in various ways.[1] In the first of these (1) the types of educational training received both by Fellows and members were shown; (2) the employment status of the members only is presented because, unfortunately, the necessary information concerning the Fellows was not available. A comparison was made, however, between graduates and nongraduates. The same data were presented in two additional tables indicating the colleges in which the training was received and the groups to which the graduates of the individual schools are allocated as to employment. The principal schools offering courses in ceramics and the number of students graduated from each were also shown.

[1] See *Bull. Amer. Ceram. Soc.*, **16** [3] 116–20 (1937).

REPORT OF THE ANNUAL MEETING OF THE MINERAL INDUSTRIES EDUCATION DIVISION

American Institute of Mining and Metallurgical Engineers

By A. F. Greaves-Walker

The meetings in New York City were held Sunday afternoon and evening, February 14, and Thursday morning and afternoon, February 18.

At the Sunday meetings, reports of various E.C.P.D. officials were presented. H. C. Parmelee, McGraw-Hill Company, made a significant statement that, in referring to specialized curricula, the Engineer's Council for Professional Development did not include ceramic engineering which is now well established. This statement shows a change in attitude from that taken by every E.C.P.D. official I contacted earlier in the year.

Dr. Parmelee is a member of the committee that visited the North Atlantic and New England institutions. The educators (there were 75 to 100 present) appeared pleased to have a representative of the American Ceramic Society present and wished primarily to find out definitely whether we were aligning ourselves with the chemical engineers or the mining engineers.

They stated that a Mineral Industries group with interests in common had been developing during the past few years. Definitely included in this group are the mining, metallurgical, geological, and petroleum engineers and fuel technologists. They noted that at Penn State and elsewhere the ceramic engineers are included, and they wanted to know if this definitely is our selection and if, in the future, we will work with the group where the interests are common. There was no question about absorbing us or taking us in. They seem to feel definitely that we have established ourselves and that we stand on our own feet.

At the Thursday session, I assured the group that we do consider ceramic engineering and ceramic technology as being in the Mineral Industries field and that we wish to coöperate with them in every way possible. I read to them the definition of ceramic engineering* developed at the Columbus meeting and they felt that this settled the matter. Professor Plank, Chairman of the Mineral Industries Education Division, assured us that the mining and metallurgical engineers do not have the slightest intention of attempting to absorb ceramic engineering but only to include it as one of their group on parity with others. He asked me particularly to assure the American Ceramic Society on this point.

* For this definition, see the March *Bulletin*, pp. 112-13.

I had an interview with Mr. Henlein, one of the secretaries of E.C.P.D., in which he asked me if Mr. White, as a representative of the American Ceramic Society, expressed the opinions and desires of the ceramic engineeers, and I assured him that he did. I told him of the proposed Institute of Ceramic Engineers, and he thought it a splendid idea.

The institute idea also appealed to other members of the A.I.M.E. with whom I talked as they felt it would give the ceramic engineers a status they had not had heretofore.

The A.I.M.E. Educational Division decided at this meeting to publish a booklet for distribution to high-school students (similar to the booklet, Engineering, a Career and a Culture), which will describe the various fields or branches of engineering in the mineral industries. They have the money and are to proceed at once to prepare the manuscript. Although I was without authority to do so, I suggested that they include ceramic engineering and ceramic technology, and this they agreed would be an excellent idea because it would define our field and definitely classify us. Professor Plank, who is a good friend of ceramic engineering, will probably head the editorial board.

When this booklet is completed, they expect to publish a larger volume covering the same subjects but written especially for men of college age.

I might add at this point that in the booklet, Engineering, a Career and a Culture, ceramic engineering is named as a branch of chemical engineering.

On the whole I feel the trip was a splendid "missionary" venture. It supported the conclusion I have reached in attending meetings of engineers during the past year, that the ceramic group has failed to impress itself on other engineering groups because it has not presented itself to them and defined its field. Sending representatives to various meetings in the future will, I am sure, pay excellent dividends. E.C.P.D. is a continuing organization, and there are apparently many ways in which we can coöperate with it to our advantage.

In the matter of registration by State Boards, we can also obtain necessary recognition only by working on and with the groups that control the situation.

YOU CAN DO NOTHING FOR THE AMERICAN CERAMIC SOCIETY

All That You Can Do by and through this Society, You Do for *Yourself and Fellow Ceramists*

AUDIT REPORT AMERICAN CERAMIC SOCIETY FOR 1936*

Columbus, Ohio, February 27, 1937

American Ceramic Society,
Columbus, Ohio.

Gentlemen:

In making my annual report on the audit of the accounts of the American Ceramic Society for the year 1936, I am attaching statements as follows:

I. Statement of Assets and Liabilities as of December 31, 1936.
II. Statement of Income and Expenses for the year.
III. Comparative Statements of Income and Expenses for the years 1934, 1935, and 1936, and Division of Income and Expenses for 1936 as to Publication and General.

As per our previous report, all inventories were written off in 1935; thus the only inventory in this report is for equipment purchased during the year, $500.82, for Office Equipment.

The securities were not available to the auditor for examination, and they have been listed as per the records on the books. Under date of June 19, 1936, the Treasurer reports the exchange of the $2000 in First Liberty Bonds and accrued past due interest on them and on the $400 U. S. Treasury Bonds for $2062.50 of U. S. Savings Bonds, which in ten years will mature at a valuation of $2750. Interest accruing on these U. S. Savings Bonds is added to the value of the Bonds, which in ten years will make them worth one-third more than cost. We have accrued the pro rata part of this interest and added to the book value of the bonds; we have also taken credit for the October and December coupons on the $400 of U. S. Treasury Bonds, which apparently have not been clipped and deposited.

Cash receipts were properly recorded and deposited, and payments were made by properly signed and approved vouchers. Cash balances have been verified and found to be as listed in this report.

It is my opinion that this report correctly shows the financial transactions for the year, as well as the true balances at December 31, 1936.

Respectfully submitted,
—A. L. PETERS,
Certified Public Accountant

STATEMENT OF ASSETS AND LIABILITIES

ASSETS

Cash in Bank (inc. Fellow account)	$10,350.43	
Revolving Fund (Bank)	389.99	
Petty Cash in Office	5.00	$10,745.42
U. S. Savings Bonds	2,092.60	
U. S. Treasury Bonds, 3 3/8% (200)	199.74	
U. S. Treasury Bonds, 4 1/4% (200)	209.42	2,501.76
Accounts Receivable	2,119.54	
Accrued Interest	7.60	2,127.14
Office Equipment (purchased in 1936)		500.82
TOTAL ASSETS		15,875.14

LIABILITIES

Accounts Payable		$2,306.85
Reserve for Fellow Dues		3,027.71
Deferred Income (Prepaid)		
Corporation Dues	$2,000.00	
Personal Dues	5,418.41	
Subscriptions	1,186.05	
Orton Medallion	16.00	8,620.46
TOTAL LIABILITIES (or Deferred)		$13,955.02
SURPLUS (Assets over Liabilities)		1,920.12

INCOME AND EXPENSE STATEMENT

INCOME

Dues Earned	Corporation	$ 5,001.78	
	Personal	17,325.02	$22,326.80
Publications, Subscriptions and Sales, 1936		4,356.26	
Previous Years, Sales		1,133.71	5,489.97
Advertising		10,932.33	
Reprints (net)		128.15	
Society Key		18.32	
Miscellaneous		40.44	11,119.24
TOTAL INCOME			38,936.01

EXPENSES

Cost of Printing		15,646.82	
Abstracts		847.38	
Editorial Office Expense		1,274.93	
		17,769.13	
Salaries	15,372.29		
Secretary's Office Expense	1,910.40		
Postage	1,256.17		
Office Rental	960.00		
Interest (net)	97.95		
Annual Meeting (net)	365.92		
Traveling Expenses	847.53		
Divisional Expenses	257.93		
Miscellaneous	307.33		
Bad Accounts	120.00	21,495.52	
TOTAL EXPENSES			39,264.65
EXPENSES OVER INCOME			328.64
SURPLUS ACCOUNT			
Balance January 1, 1936			2,248.76
Less Expenses over Income, 1936			328.64
Surplus Balance December 31, 1936			1,920.12

ONWARD SAILS

THE GOOD SHIP CERAMICS

More Participants—More Profits, Personal and Corporate

"When my ship comes in"—what a dream! But for you this dream can come true.

The American Ceramic Society ship is owned coöperatively for advancing the art, science, and technology of ceramic ware production. It represents the ambition and needs of each and all ceramic persons and corporations: It is theirs to navigate and to improve.

Why not do your part to make this, your ship, better able to make deliveries to you in a larger way? More members and more advertising are essential—but of far more importance is the determination of each ceramic person and corporation to do his part.

1937 MEMBERSHIP RECORD

Date of Record	Members Paid		Deferred	Subscriptions	Monthly Sales	Total Circulation
	Personal	Corporation				
December 20, 1936	1452	196				
January 20, 1937	1478	199				
February 23, 1937	1579	210	19	515	220	2543
March 29, 1937	1613	212	18	524	220	2587

Nearly two additional members per day. Every Ceramic Corporation should "get aboard." Will you sell them on this idea?

NEW MEMBERS*

Corporation

GREAT LAKES FOUNDRY SAND CO., J. Muhlitner (voter), 720 United Artists Bldg., Detroit, Mich.

HOCKING GLASS CO., William V. Fisher (voter), Lancaster, Ohio.

KAOLIN, INC., C. R. Ricker (voter), Spruce Pine, N. C.

SAN MIGUEL BREWERY, INC., Andres Soriano (voter), Manila, P. I.

SUMMITVILLE FACE BRICK CO., H. K. Lynn (voter), Summitville, Ohio.

UNITED STATES GYPSUM CO., J. A. F. Wendt (voter), 300 W. Adams St., Chicago, Ill.

Personal

BALDWIN, WILLIAM J., 67 N. Duane Ave., Ingram, Pittsburgh, Pa.; Industrial Fellow, Mellon Institute.

BOHN, E. L., P. O. Box 58, Annex Sta., Cincinnati, Ohio; sales manager, Fire Clay Refractories Div., Charles Taylor Sons Co.

BLUE, JOHN T., East Liverpool, Ohio; R. Gaertner & Co.

CLOWES, EDWIN A., 5872 Ellsworth Ave., Pittsburgh, Pa.; president and treasurer, McCullough-Dalzell Crucible Co.

DOBROVOLNY, FRANK J., E. I. du Pont de Nemours & Co., R. & H. Chemicals Dept., Niagara Falls, N. Y.

ENGSTROM, A. H., 776 S. Swanson St., Philadelphia, Pa.; vice-president, Botfield Refractories Co.

FRAHME, HERMAN H., 331 W. Milton Ave., Rahway, N. J., ceramic engineer, General Ceramics Co., Keasbey, N. J.

GALLAGHER, E. FRANCIS, 22 Beacon St., Boston, Mass.; engineer, New England Brick Co.

HARVEY, E. M., Pomona Terra Cotta Co., Pomona, N. C.

HOSTETTER, JOHN R., 15 East 5th St., Corning, N. Y.; Development Lab., Fibre Div., Corning Glass Works.

*HOUSER, VICTOR F., 4118 E. 58th St., Maywood, Calif., ceramic engineer, J. A. Bauer Pottery Co., Los Angeles.

HOWER, EDWIN N., 610 A-13th Ave., Munhall, Pa.; assistant general masonry foreman, Homestead Steel Works, Carnegie-Illinois Steel Corp.

*KENAGY, WILLIAM L., 7821 Verree Rd., Philadelphia, Pa.; ceramic engineer in charge of control, Abrasive Co.

KIRCHNER, ALFRED M., 864 Frick Annex Bldg., Pittsburgh, Pa.; contact man, Metallurgical Dept., Tin Plate Div., Carnegie-Illinois Steel Corp.

LORING, ALBERT D., 19 Ross St., Somerville, N. J.; assistant physicist, Johns-Manville Research Laboratories.

MCALPINE, KENNETH B., 933 Saint James St., Pittsburgh, Pa.; Industrial Fellow, Mellon Institute.

MARMON, HOWARD C., Pineola, N. C.; president, Kaolin, Inc.; vice-president, Carolina Kaolin Corp.

MILLER, BEN K., 911 East Love St., Mexico, Mo.; ceramic engineer, A. P. Green Fire Brick Co.

OBULJEN, PEDRO M., P. O. Box No. 1199, Santiago de Chile, S. A., partner of Obuljen, Mardones & Pacheco, Ltd.

PEARLMAN, SAMUEL B., 1027 Metropolitan Ave., Brooklyn, N. Y.; enameling superintendent, Bright Light Reflector Co.

PORTER, RUDYARD, 1935 Orrington Ave., Evanston, Ill.; metallurgist, Carnegie-Illinois Steel Corp., Chicago.

PRUTTON, CARL F., 11000 Euclid Ave., Cleveland, Ohio; Chemical Engineering Dept., Case School of Applied Science.

RICKER, CLAYTON R., Spruce Pine, N. C.; general manager, Kaolin, Inc.; president, Carolina Kaolin Corp.

SCHAULIN, GEORGE M., 288 Sundale Road, Akron, Ohio; production superintendent, sewer-pipe manufacture, Robinson Clay Product Co.

SIMISON, A. L., Owens-Illinois Glass Co., Newark, Ohio; ceramic engineer.

SIMPSON, ERNEST, High View Fenton Manor, Stoke-on-Trent, Staffordshire, England; managing director, brickworks.

WAINFORD, R. H., JR., Ceramic Feldspar Corp., Trenton, N. J.

WHITMAN, RAYMOND C., 154 Watchung Ave., Chatham, N. J.; sales development, Monsanto Chemical Co., Akron, Ohio.

WORK, LINCOLN T., Havemeyer Hall, Columbia University, New York, N. Y.; Chemical Engineering Dept.

WULFF, ROBERT G., Tennessee Eastman Corp., Kingsport, Tenn.

YARTE, ANDREW A., Troqueles Yesmaltes, Apartado 371, Monterrey, N. L., Mexico; superintendent enamel department.

Student

BROUK, J. JOHN, University of Illinois.

EARHART, WILLIAM H., Ohio State University.

FAY, MERVIN A., Pennsylvania State College.

KOENIG, JOHN H., Ohio State University.

TOMKINS, DAVID E., Pennsylvania State College.

MASSENGALE, GORDON, University of Alabama.

ZERFOSS, SAMUEL, Pennsylvania State College.

ZIMMER, WARREN A., Ohio State University.

* Indicates former member of the Society rejoining for 1937.

ROSTER CHANGES DURING MARCH*

Corporation

NORTH CAROLINA FELDSPAR CORP., W. F. Deneen (voter), Erwin, Tenn. (North State Feldspar Corp., Trenton, N. J.)

FRAZIER-SIMPLEX, INC., C. E. Frazier (voter), Washington Trust Bldg., Washington, Pa. (Simplex Engineering Co.)

Personal

BARKWELL, BERNARD T., 3, Marstone Crescent, Totley, Sheffield, England. (Woodseats, Sheffield)

BEASLEY, HERBERT C., Ferro Enamel Corp., Cleveland, Ohio. (Baltimore, Md.)

BLAHA, EMIL, 117 W. Spencer St., Philadelphia, Pa (Fords, N. J.)

* Address in parentheses is the old address.

BLANCHARD, JAMES R., Climax Molybdenum Co., Detroit, Mich. (Lancaster, Ohio)

BLUME, ARTHUR J., Ferro Enamel Corp., Cleveland, Ohio. (Haddonfield, N. J.)

BRAY, KENNETH J., 2152 N. Meridian St., Indianapolis, Ind. (Pendleton, Ind.)

BRENNER, R. F., Hocking Glass Co., Lancaster, Ohio. (Toledo, Ohio)

DEBENHAM, WILLIAM S., 7715 South Shore Drive, Chicago, Ill. (Danville, Ill.)

CANFIELD, RUTH E., Friendship, N. Y. (New York, N. Y.)

CLARK, C. BURTON, Frankfort, Ind. (Student, Univ. of Illinois)

ELLEFSON, BENNETT S., Research Laboratories, Hygrade Sylvania Corp., St. Marys, Pa. (Student, Pennsylvania State College)

HUBBARD, ARTHUR E., 64 Psalter Lane, Sharrow, Sheffield, England. (London)

KEY, JOHN A., Cerro de Pasco Copper Co., Oroya, Peru, S. A. (Student, Univ. of Washington)

LINDLEY, JACOB, Tiltonville, Ohio. (Athens, Ohio)

PEARCH, WILLIAM M., Akron Porcelain Co., Akron, Ohio. (Anderson, Ind.)

THORNBERRY, MARTIN H., 3948 Utah Ave., St. Louis, Mo. (Rolla, Mo.)

TRABERT, LOREN A., 1727 3/4 W. 52nd St., Los Angeles, Calif. (Inglewood, Calif.)

WALDSCHMIDT, MILTON H., 310 Mainview Apts., Central and 25th Sts., Anderson, Ind. (Columbus, Ohio)

WEBSTER, CHARLES E., McCullough-Dalzell Crucible Co., 36th St. and A. V. Ry., Pittsburgh, Pa. (Louisville, Ky.)

WINBURN, H. L., Ludowici-Celadon Corp., 715 Rector Bldg., Little Rock, Ark. (Benton, Ark.)

WITSCHEY, R. A., A. P. Green Fire Brick Co., Mexico, Mo. (Columbus, Ohio)

MEMBERSHIP WORKERS' RECORD

Corporation

A. V. Bleininger	1	S. R. Scholes	1
R. F. Brenner	1	J. E. Wiss	1
J. L. Cruikshank	1	Office	1
			6

Personal

R. E. Arnold	1	F. M. Hartford	1
J. B. Austin	1	E. C. Hill	1
M. G. Babcock	1	J. C. Hostetter	1
J. H. Borkey	1	H. E. Romine	1
R. S. Bradley	1	H. E. Simpson	1
G. H. Brown	1	N. W. Taylor	1
R. R. Danielson	1	H. F. Vieweg	1
Walter Emery	1	Office	15
C. F. Geiger	1		
			31

Student

A. I. Andrews	1	J. G. Mohr	1
J. L. Carruthers	1	N. W. Taylor	2
J. O. Everhart	2		
T. N. McVay	1		
			8
		Grand total	**45**

NECROLOGY

JOSEPH CARL PARKINSON

Joseph Carl Parkinson died January 19, 1937, from a blood-stream infection, following a severe attack of pneumonia.

Mr. Parkinson was born at Niagara Falls, August 18, 1883. He was graduated from Niagara Falls High School, and his first work was with the Aluminum Company of America at its plants located at Niagara Falls and Massena, N. Y. During this time he pursued four years of night-school work and four years of correspondence school work in chemical engineering. On April 15, 1912, he joined the Research Department of the Pittsburgh Plate Glass Company and was there continuously until his death. He leaves his wife, Mrs. Madeline DeQuinze Parkinson, and three children, Patricia, Felicia, and Walsh.

Mr. Parkinson became a member of the American Ceramic Society in 1920.

LEONARD BISHTON-BOTFIELD

Leonard Bishton-Botfield, President of the Botfield Refractories Company, Philadelphia, Pa., and also President of the Canadian Botfield Refractories Company, Ltd., Canada, died May 5, 1936, at Philadelphia. He was fifty-five years old.

Mr. Botfield was affiliated with the refractories industry for many years, succeeding his father, A. Bishton-Botfield, as President of the Botfield Refractories Company in 1916. He was an outstanding figure in the refractories industry and pioneered and was responsible for numerous important developments in the manufacture of high-temperature cements. Mr. Botfield was National Chairman of the High-Temperature Bonding Mortar Division of the American Refractories Institute and also a Director of the Institute.

He had held a membership in the American Ceramic Society since 1923.

G. W. ANDERSON

G. W. Anderson, Ocean Springs, Miss., died on February 23, 1937. Mr. Anderson, with his wife and their three sons, Peter, James, and Walter, operated the Shearwater Pottery at Ocean Springs.

FRANK M. RANSBOTTOM

Frank M. Ransbottom, Zanesville, Ohio, died February 28, 1937, at the age of sixty-three years.

He and his three brothers, Edwin M., Charles M., and Mort G. Ransbottom, organized the Ransbottom Pottery Company in 1901. In 1919 he organized the American Clay Products Company. He was a member of the board of directors of the Federal Home Loan Bank of Cincinnati,

Past Grand Master of Ohio Masonry, a 33rd degree Mason, and Past Grand Commander of the Ohio Commandery, Knights Templar. His wife and three daughters survive.

Frank M. Ransbottom

Followed Father's Trade

The knowledge of the pottery business which Mr. Ransbottom gained under the tutelage of his father proved a stepping stone to the commanding position in the industry he occupied later in life.

He was born on a farm near Roseville, Perry County, June 19, 1873, the son of Alfred and Ruth Wickham Ransbottom. Alfred Ransbottom's father, a Virginian of English descent, migrated to Delaware County and operated a pottery. Alfred Ransbottom followed his father's trade and moved to Muskingum County, where he opened a small pottery, operating it in conjunction with another he owned in Licking County.

Salesman at Nineteen

Frank Ransbottom attended public school in Roseville until he was 14, when he went to work in his father's pottery, learning the trade, and working at it until, at the age of 19, he became a salesman for the Crooksville Pottery Co.

It was inevitable that his success in his own field of endeavor should lead him into other business. He was president of the First Trust & Savings Bank, Zanesville; and a director of the First National Bank, Zanesville; the American National Fire Insurance Co., Columbus; the Home Building & Loan Co., Roseville; and the Zanesville Fruit Co.

From the day he became of age, he was interested in politics. He was long recognized as a power on national and state Republican campaign committees.

LOCAL SECTIONS

CENTRAL OHIO SECTION

A meeting of the Central Ohio Section of the American Ceramic Society in conjunction with the Columbus Section of the American Chemical Society was held March 12 at Ohio State University, following a dinner in honor of Charles E. Marshall of The University of Missouri. Dr. Marshall spoke on "The Nature of Clays" and presented, by word and illustrations, a picture of the structure of colloidal clay or soil matter, emphasizing the crystalline (instead of amorphous) nature of the minute mineral fragments, bringing into accord the structural arrangement with the chemical formula, and accounting for hydration and replacements within the separation of the structural lattices.

The fundamental work of the English investigator, Pawling, was commented upon in that he proved by X-ray investigation the identical structural unit for SiO_2 (β-cristobalite), $Al_2(OH)_6$, $Mg_3(OH)_6$, the micas, chlorite, kaolin, pyrophyllite ($Al_2O_3 \cdot 4SiO_2 \cdot H_2O$), and talc. This work was checked and extended by the German investigators Hofmann, Endell, and Wilm to the structure of montmorillonite, beidellite, and nontronite.

—T. W. GARVE, *Secretary*

MICHIGAN-NORTHWESTERN OHIO SECTION

The February meeting and annual election of officers of the Michigan-Northwestern Ohio Section of the American Ceramic Society was held Friday, February 26, at the Medea Hotel in Mt. Clemens.

Ross C. Purdy, General Secretary of the American Ceramic Society gave an enlightening and interesting talk on "The Value of a Ceramic Education."

The officers elected for the year 1937–38 are as follows:

President, TOM PLACE, Mt. Clemens Pottery

Vice-President, KARL SCHWARTZWALDER, A C Spark Plug Company

Secretary-Treasurer, LEONARD TAIT, Champion Spark Plug Co.

The next meeting will be in Detroit, May 14, 1937. A. V. Bleininger, Director of Research, Homer Laughlin China Co. will speak on "The Future of America Pottery."

—L. G. TAIT, *Secretary*

ST. LOUIS SECTION

A meeting of the St. Louis Local Section, the American Ceramic Society, was held on Friday, March 5, 1937, at Little Bevo, South St. Louis, Mo.

The program included an afternoon and evening session, with dinner at 6:30 o'clock. The speakers and papers given on the afternoon program were as follows:

(1) "Various American Methods of Load Testing of Refractories"
BY C. M. DODD: Rolla School of Mines.
(2) "Enamels, Glass, Refractories, and Other Things"
BY C. W. PARMELEE: University of Illinois.
(3) "Use of X-Ray in Ceramic Research"
BY PAUL G. HEROLD: Rolla School of Mines.
(4) "Bonding Mortars, Their Properties and Uses"
BY J. L. CRAWFORD: Walsh Refractories Corporation.
(5) "Modern Methods of Testing Refractories within the Works Laboratory"
BY R. S. BRADLEY: A. P. Green Firebrick Company.

The evening program was as follows:

(1) "The Ceramic Department of the Rolla School of Mines"
BY C. M. DODD
(2) "The Ceramic Department of the University of Illinois"
BY C. W. PARMELEE
(3) "One Hundred Fifty Years of Ceramics in America"
BY R. C. PURDY: General Secretary of the American Ceramic Society.

Herbert A. Wheeler, the Society's first President, gave a brief historical statement, setting forth the visions and ambitions of the twenty Charter Members. These, compared with the Society as it exists today, exceed by manyfold those early ambitions of the Charter Members.

—R. L. BLESSING, *Secretary*

BALTIMORE-WASHINGTON SECTION

The Baltimore-Washington Section met on February 20 for dinner at Tilden Gardens, Washington, D. C. Twenty-four members were present.

After dinner the group and a number of guests assembled in the lecture room of the Chemistry Building at the National Bureau of Standards. The speaker, R. A. Barr of the Carborundum Company, discussed "Super-Refractories," using two reels of moving pictures to illustrate the discussion.

The members were greatly interested in the film, made with the aid of the thermal microscope, showing the actual progress of reactions occurring at high temperatures between acidic and basic glasses and several types of refractories. The film in color, made by the Kodachrome process, showed the appearance of thin sections of a number of refractory materials rotated on the stage of a petrographic microscope.

—G. R. SHELTON, *Secretary*

ANNUAL REPORTS OF INDUSTRIAL DIVISIONS

STRUCTURAL CLAY PRODUCTS DIVISION OFFICERS

The results of vote count for 1937–38 officers of the Structural Clay Products Division of the American Ceramic Society are as follows:

Chairman, D. A. MOULTON: Standard Brick and Tile Corp., Evansville, Ind.

Vice-Chairman, C. P. AUSTIN: Binghamton Brick Co., Inc., Binghamton, N. Y.

Secretary, T. W. GARVE: 235 West Tenth Ave., Columbus, Ohio.

—EUGENE C. CLEMENS, *Secretary*

ENAMEL DIVISION REPORT OF COMMITTEE ON STANDARDIZATION OF TESTS*

BY W. H. PFEIFFER

The National Bureau of Standards, in its program for the development of standard test methods for enamels and enameled products, at the request of the Technical Research Section of the Porcelain Enamel Institute[1] developed a method for testing the reflectance of enamels which has been adopted tentatively by the Technical Research Section[2] and published in June, 1936. It is recommended that this test method be observed by the Enamel Division and considered in its present or in a revised form for adoption as a standard method.

The National Bureau of Standards[1] is also engaged in the development of tests for acid resistance and abrasion resistance of enamels.

The 1936 Committee on Standardization of Tests took no direct action but rather coöperated with the National Bureau of Standards in the above-mentioned work. It is recommended that such coöperation be continued.

* Received March 16, 1937.

[1] E. C. Crittenden, "Advisory Committee on Enamels Suggests New Research at National Bureau of Standards," *Bull. Amer. Ceram. Soc.*, **14** [1] 47 (1935).

[2] Porcelain Enamel Institute, Inc., "Reflectance Test for Opaque White Porcelain Enamels," *Bull. Technical Research Sec.*, June (1936).

WOULD YOU PAY

(1) $4.17 for a report of original research?

In 1936, the American Ceramic Society published 100 such reports, several of which were worth to you many times $4.17 per report.

(2) $4.17 for an abstract of an article?

In 1936, the American Ceramic Society published 4953 abstracts, many of which were worth this $4.17 to you.[1]

(3) $4.17 for a share in an organized promotion of ceramic education and research?

"Yes, sir!" is the answer to each of the questions by more than 1600 persons. Their judgment, singly and combined, can not be wrong.

These sums total $12.50, a personal membership dues in this coöperative Society.

LAWRENCE E. BARRINGER TO EUROPE

Mr. and Mrs. Lawrence E. Barringer, Schenectady, N. Y., left for Europe shortly after the Annual Meeting in New York. Mr. Barringer will attend the Second Congress of the International Association for Testing Materials, London, April 19 to 24, where he will present a paper entitled, "Testing of Electrical Porcelain." While abroad Mr. Barringer will visit important museum exhibits and outstanding industrial plants to continue his studies of ceramic art, history, and technique.

Valuable Bibliographies, a complete Ceramic Book List, and a Supplement to the Equilibrium Diagrams are in preparation, in addition to the regular monthly publications.

PROPOSED AMENDMENTS TO THE CONSTITUTION*

Present

Article III

(1) The membership of THE SOCIETY shall consist of the following classes:

(2) The Board of Trustees may declare any Fellow, Member, or Corporation Member to be a Life Member in the same class of membership, in the manner and upon the conditions provided in the By-Laws.

(3) The following classes of members shall be entitled to vote on matters pertaining to THE SOCIETY as a whole or its regularly constituted Divisions: Fellow, Member, Voter of Corporation Member, and Life Member of these classifications.

(4) The following classes of members shall be entitled to hold office: Fellow, Member, and Life Member of either classification.

Article IV

(1) The management of the affairs of THE SOCIETY shall be vested in a Board of Trustees, consisting of the President of THE SOCIETY, the Vice-President, the Treasurer, the two most recent living Past-Presidents, and a representative of each Division of THE SOCIETY.

(2) . . . . . The term of office of the Trustee representative of each Division shall be three years, to wit: . . . . .

(4) (*c*) To determine questions of jurisdiction arising between the various Divisions, Fellows, Local Sections, Student Branches, Committees, and other subdivisions of members of THE SOCIETY.

Article VII

(4) Each year the members of those Divisions of THE SOCIETY whose Trustees' triennial terms expire at the forthcoming Annual Meeting shall, by plurality written vote more than thirty (30) days before the opening date of the said Annual Meeting, elect a representative . . . . .

(5) In the event of the refusal to act, or incapacity to act, of a Trustee representative of a Division, the members of such Division shall, by plurality written vote, elect a successor . . . . .

New

Article VIII—Classes

(1) Fellows and Members may be grouped into Classes according to their training and experience as provided in the By-Laws.

(2) Each Class may elect officers and conduct business as provided in the By-Laws.

(Present Article VIII becomes Article IX and subsequent Articles are renumbered.)

---

* See *The Bulletin* for June, 1936, page 200; for the reasons for these proposed changes see *The Bulletin* for March, 1937, page 122.

Proposed

Article III

(1) The membership of THE SOCIETY shall consist of the following grades:

(2) The Board of Trustees may declare any Fellow, Member, or Corporation Member to be a Life Member in the same grade of membership, in the manner and upon the conditions provided in the By-Laws.

(3) The following grades of members shall be entitled to vote on matters pertaining to THE SOCIETY as a whole or its regularly constituted Divisions: Fellow, Member, Voter of Corporation Member, and Life Member of these grades.

The following grades of members shall be entitled to vote on matters pertaining to the regularly constituted Classes of THE SOCIETY: Fellow, Member, and Life Member of these grades.

(4) The following grades of members shall be entitled to hold office: Fellow, Member, and Life Member of these grades.

Article IV

(1) The management of the affairs of THE SOCIETY shall be vested in a Board of Trustees consisting of the President of THE SOCIETY, the Vice-President, the Treasurer, the two most recent living Past-Presidents, a representative of each Class of THE SOCIETY, and a representative of each Division of THE SOCIETY.

(3) . . . . . The term of office of the Trustee representative of each Class, and the term of office of the Trustee representatives of each Division shall be three years, to wit: . . . . .

(4) (*c*) To determine questions of jurisdiction arising between the various Classes, Divisions, Fellows, Local Sections, Student Branches, Committees, and other subdivisions of members of THE SOCIETY.

Article VII

(4) Each year the members of those Classes, and the members of those Divisions whose Trustees' triennial terms expire at the forthcoming Annual Meeting shall, by plurality written vote more than thirty (30) days before the opening date of the said Annual Meeting, respectively, elect a representative . . . . .

(5) In the event of the resignation, refusal to act, or incapacity to act, of a Trustee representative of a Class or Division, the members of such Class or Division shall, by Plurality written vote, elect a successor . . . . .

New

Article XII—Committees

(3) Each Class shall appoint such members of general committees of THE SOCIETY as the By-Laws of THE SOCIETY may currently require, the manner of such appointment to be as provided in the Rules of each Class.

COMMUNICATIONS—CERAMIC HISTORY

WALTER SCOTT LENOX*

By George Sanford Holmes

Civilization owes everything to the idealist. It is he who has pioneered in all phases of human development. Perhaps he is endowed with a "single track" mind, as is frequently charged, but singleness of purpose seldom fails to beget results, and it is by results that we are judged. What a pity it is that all too often posterity alone is fitted to render a verdict! For the contemporary world is prone to call that man a dreamer whom history pronounces a genius.

The most barren life is that which lacks ideals. Power, position, pelf—none of these can supply their want. Ideals feed the spirit, the inner man. He who is true to his ideals, even though he fail to attain them, has lived richly, for he has kept faith with himself and his fellows and has made the world better.

None but the idealist can withstand the bludgeonings of fate and lift his head undaunted and uncowed and try again. None but the idealist possesses the infinite patience which builds the perfection of tomorrow out of the mistakes and errors of countless yesterdays and todays. None but the idealist can wring from a broken body the tribute of success exacted by an unbroken will. None but an idealist can fire in others the white-hot flame of devotion, enthusiasm, and self-sacrifice with which he himself is consumed.

Ideals—what would the world be without them? A morass of materialism, without hope, without aspiration, without progress. It is only by ideals that we lift ourselves from one plane to another in the slow and painful process of self-development and self-fulfillment. They are the only worth-while things in life, after all, for life without them becomes but animal existence, a mere succession of days on the treadmill of time.

The history of Lenox china is the history of Walter Scott Lenox—and the history of Walter Scott Lenox is a modern epic of idealism. It is a story that a few have always known, those who knew and loved him in life, but the time has come, we believe, when it should be told to the American people, that native pride may be stimulated by the example of one who consecrated his life to the sole ideal of elevating American ceramic art to a place of primary importance. For this ideal he lived and labored and died. To it he clung with a passionate loyalty; through it he became America's foremost potter, fitted by the standards of trial or triumph, suffering or success, to rank with the Palissys and Wedgwoods and master potters of other times.

The seeds of genius do not long lie dormant, even though they flower late. Born in Trenton, New Jersey, in 1859, Walter Scott Lenox was but a schoolboy when the sight of the potter's wheel awoke in him those longings which later led him along the paths of greatness. He was fascinated by the evolution of dull clay into shapes and forms of beauty in a little pottery which he passed daily on his way to and from school, and he would spend hours watching the workers fashion the plastic earth into articles of usefulness and service. Thus environment helped to mold his destiny and the oldest of man's arts aroused instincts in the ordinary American school lad which were to confer luster upon his name in after years. There was then born in him not merely the ambition to become a potter but the desire to excel, a desire without which Walter Scott Lenox would have remained only a potter instead of developing into a genius.

The urge to excel, to do things better than the other fellow, to establish higher standards—what an ideal to kindle the breast of a mere boy! To make pottery, yes, that was the craving of the youthful Lenox as he lingered at the potter's wheel on his way to his daily lessons; but that was not all, for he would make better pottery, or none at all.

With Ott and Brewer

And so this youth became a potter, learning the rudiments of a trade before essaying the possibilities of an art. He served an apprenticeship in the Ott and Brewer factory and the Willetts Pottery of Trenton, mastering the practical details of the work while studying decoration in his leisure hours. With the development of his artistic talent the young potter became more and more interested in decorative and creative effort and eventually became art director of the Ott and Brewer factory.

Ceramic Art Company with Jonathan Coxon, Sr.

There was little of the artistic in the American ceramic products of that period. Design was crude, expression exaggerated. Lenox, dreaming of better things, yearning for an opportunity to give vent to his own aspirations and individuality, perceived the fact that only by establishing his own factory could he attain his own ideals of producing a grade of china equal to the finest created abroad. In 1889, therefore, he finally effected a partnership with the late Jonathan Coxon, Sr., in the Ceramic Art Company, which they operated together until 1894. Lenox then acquired the interest of his partner and from that time until 1906, he conducted the business alone, when he organized Lenox, Inc., under which form the pottery has since been operated.

Lenox, Incorporated, 1906

Just what this daring dream has meant to ceramic art in America is now gratefully appreciated, but at the time the experiment was regarded doubtfully by others. The flame of a zealot glowed in the heart of Lenox. Not so in the hearts of some of his backers, who stipulated that the factory he erected at the corner of Mead and Prince streets

* Taken from book of the same title published in 1924 for private circulation only.

in Trenton should be so constructed as to be converted into a tenement building should the pottery fail. Fortunately, there existed neither doubt nor misgiving in the mind of the young potter, who began in this classic old structure his inspired mission of improving American pottery.

A china factory is a commercial proposition; it is an adventure in applied art. It must show a profit to succeed

Walter Scott Lenox

and endure. When we say, therefore, that the thought of financial return was secondary to his artistic ideals, we do not mean to impugn the sound business judgment of Walter Scott Lenox. He had but one standard—quality, and he knew that in the end it would be successful and that the public would ultimately recognize it. But at what a cost!

There were years and years of struggle; of heavy expense and light income; of increased production and decreased sales; of straitened circumstances and hectic financing; of pessimistic outlook and discouraged backing. Friends urged him to give up the experiment. They pointed out to him that there was a sure profit in cheaper ware which the American market would quickly absorb, but Lenox was adamant in his determination to make no compromise with his conscience. Nothing could stir him from his resolution to make the best china of which he was capable, or none.

There is an inspiration in this tragic fight for artistic recognition and supremacy. It was a battle of peace no less arduous than a battle of war. It was a conflict between a man's honor and expedience; between his ideals and others' ideals. When Walter Scott Lenox, in 1889, began the manufacture of china which was designed to rank with the finest porcelain produced elsewhere, many American manufacturers were in the habit of stamping their ware with English marks in order to sell their goods. No one dreamed that an American factory could turn out china of the first quality. The public of the United States believed that foreign ware alone was worth purchasing and domestic china was given scant consideration. Yet young Lenox, true to his principles and courageous to the end, never descended to the subterfuge of marking his products with a fraudulent foreign label, but was insistent that the world pass judgment upon his own handiwork at its intrinsic worth. He was at all times both artist and patriot.

It was entirely due to the unconquerable spirit of this master potter of America that Lenox ware little by little obtained the recognition to which it was entitled. That recognition did not come in a day or a year, but gradually the discriminating public of America became aware of the fact that Walter Scott Lenox was creating, in his factory at Trenton, New Jersey, a type of china fitted to grace the table of a connoisseur and compete on equal terms with the highest grade products of the famous factories of Europe.

Belleek China

That ware was termed "Belleek." It received its name from Belleek, Ireland, where it was then produced in limited quantity. Importing two Belleek potters, Lenox strove for a long time unsuccessfully to produce the beautiful, creamy, ivory-tinted ware, marked by a rich, lustrous glaze, of which he dreamed. Finally failure gave way to perfection and the result was a china which charmed by the warmth and glow of its coloring and ranked in richness and quality with the masterpieces of other lands. Today, the first piece of Belleek turned out in America is a treasured exhibit in the display room of the Lenox pottery.

Blind and Paralyzed in 1895

Feverishly toiling to create new standards of art for American potters, tremendously in debt, burning with an ambition as strong as that which urged Bernard Palissy to cast his household furniture into the oven of his kiln, Lenox, worn out by the fierce struggle to establish himself, was about to welcome unqualified success when he was stricken with a calamity which would have utterly crushed an ordinary mortal. In 1895, at the very moment when success was beginning to crown his efforts, he was over-

whelmed with paralysis and blindness, losing his sight and the use of his legs. Doomed to perpetual darkness and deprived even of the power of locomotion, none would have condemned this brave and dauntless spirit if he had then surrendered. Friends urged him to give up the fight. His physical infirmities were pointed out to him and the hopelessness of his cause painted in the blackest of hues. But the vision within him burned fiercely, a light that did not fail. With the God-given courage and fortitude of inherent heroism, he elected to go on and on and on, to a victory he could not rise to greet, to a triumph he could not see.

Wonderful indeed is the soul of man; stronger than the body, mightier than the flesh. Blindness and paralysis struck Walter Scott Lenox as he was about to reap the reward of artistic success, but at the nadir of financial resources. Obligations held him in a vise-like grip; debts hemmed him in on all sides. Should he give up now that his ware had been accepted, after the sacrifices of himself and his friends and the exhibition of confidence on the part of his backers?

Never! To pay back his debts, to free his factory of all financial obligations, to establish himself in independence became an obsession equal in intensity to that which spurred him on to artistic endeavor. And then, as a result of the tragedy which overcame him physically, developed one of the most affecting relationships of which American industry has any record. Harry A. Brown, secretary of the Company, now president, became the very *alter ego* of Walter Scott Lenox.

Harry A. Brown

"Dominie" was the name by which the blind potter called his assistant, and well did Dominie serve his superior. No more intimate or more faithful stewardship has ever been assumed than that borne by Harry A. Brown from the moment fate visited Walter Scott Lenox with the terrible affliction with which he suffered to the day of his death. The mind of the stricken potter remained as brilliant, as resourceful, as active as before, but he saw through the eyes of his loyal associate. Together they directed the destinies of the growing business and developed production until the financial breakers began to recede. Implicitly the blind genius trusted his lieutenant, and completely and eagerly the young advisor justified that confidence. The task of management fell upon his shoulders and no task was ever handled with more honor or credit or under sadder circumstances.

Financial Success Attained

To him fell the responsibility of piloting the concern through the financial billows. And to him fell the profound joy of acquainting his superior on one eventful day with the fact that the last note at the bank had been paid, the factory cleared of all encumbrances and the entire property freed of debt. Those who have been a part of Lenox, Inc., for many years, remember the tears of joy that filled the sightless eyes of Walter Scott Lenox on that occasion. Upon their memories is vividly etched the dramatic scene that took place when, at his request, a miniature kiln was built and the notes and papers burned in his office to signalize the redemption of the factory from all financial obligations and the triumph of an ideal.

Nor will they ever forget the impressive talk made to them, in the very shadow of death as well as in the noonday glare of success, by the leader who had inspired in them the same zeal and energy and ambition which actuated his own ardent nature. Under the spell of his personal magnetism, they had all worked as one individual for the success of Lenox, Inc., and under his leadership their common object had been at last attained. The blinded potter was vindicated.

Walter Lenox Dies in 1920

Until the day of his death, January 11, 1920, Walter Scott Lenox continued to visit his factory regularly, lovingly caressing the new products of "his boys" as they were turned out and endeavoring to supplement the loss of sight through the delicate nerves of his fingers. His boyhood dream had been realized. Lenox ware competed with the products of the world's best potteries. Lenox, Inc., was out of debt. And then one day he came no more.

Belleek Tableware

But the idealism, the personality, the spirit of Walter Scott Lenox live on. They permeate the factory, inspire his former associates, guide their efforts, and direct their steps. Before he died, the whole course of Lenox production had been changed by the discovery that superior table service could be made from Belleek ware. Until that time, Lenox products were principally ornamental pieces and objects of art of various types in popular vogue. With the successful experimentation in dinnerware, a new era was begun and the entire factory devoted to the output of dinnerware. The first complete service was displayed by Tiffany and Company, who had strongly encouraged Walter Scott Lenox in his ideals and efforts. Today Lenox dinner service products are to be found in homes of culture and refinement throughout the land. Indeed, the first American-made dinner service to grace the White House is composed of 1700 pieces of Lenox, while presidential sets have also been ordered from Cuba and Venezuela.

Frank G. Holmes

The driving genius of the Lenox organization was its head and founder, but with him have been associated for a score of years men who have helped make ceramic history in America. The work of Frank G. Holmes, designer, has been an important factor in the artistic development of Lenox ware. The symmetry and grace of Lenox shapes, as well as the effectiveness of the decoration, have become as famous as the ware itself. The execution of every detail connected with the decoration of Lenox china has practically from its inception been under the personal supervision of William H. Clayton. When a boy, Mr. Clayton was apprenticed to Walter Scott Lenox and learned the art of china decoration under this great master.

Quality Maintained

Today, in a new pottery, one of the finest structures devoted to the manufacture of china, Lenox, Inc., continues under the same ideals as those held by its founder. No considerations of profit will ever cause the men now in charge, protégés each and every one of Lenox, the Master Potter of America, to sacrifice quality or compromise the

high standards he erected. The blind potter died having accomplished two great achievements. He had effectually eliminated American prejudice against native china and he had established the artistic prestige of American-made goods. Both in quality of composition and design, Lenox, Inc., ware rivals the really fine ceramic products of the world. It possesses a character, a tone, a charm of its own. This is the heritage handed down by the blind potter; and this is the heritage which those who assumed his responsibilities value more than all else combined. Flattering offers for the plant and business of Lenox, Inc., have been made but they have always been rejected. They would have meant turning quality production into quantity production and a sacrifice of artistic standards—a contingency as unthinkable today as when Walter Scott Lenox was alive.

The blind potter is dead. But here, in the great, new, modern factory which has arisen on the site of the historic structure in which Lenox china was born, his soul yet lives. It is an American shrine to art, to beauty, to faith—and to idealism.

NOTES AND NEWS

RESEARCH FELLOWSHIPS IN COAL AND NONMETALLICS

The University of Washington offers four fellowships in the College of Mines for research in coal and nonmetallics in coöperation with the United States Bureau of Mines. Fellows enter upon their duties on July 1, 1937, and continue for 12 months. Payments under a fellowship amount to $720.00 for the year. The fellowships are open to graduates of universities and technical colleges who are qualified to undertake investigations. Ordinarily the appointees register as graduate students and become candidates for the degree of Master of Science in Mining or Metallurgical or Ceramic Engineering; occasionally an appointee registers for the Bachelor of Science degree in one of these curricula.

The purpose of these fellowships is to undertake the solution of various problems being studied by the United States Bureau of Mines that are of especial importance to the State of Washington, the Pacific Northwest, and Alaska. The investigations consist principally of laboratory work directed largely by the Bureau's technologists. The work is performed in Mines Laboratory, a large modern building fully equipped with the newest forms of machinery and apparatus. For the year 1937–1938 the following subjects have been selected for investigation:

(1) Coal: problems in the treatment and utilization of coal and coke.

(2) Nonmetallics: problems in kaolin, talc, soapstone, olivine, silica sand, diatomite, and other nonmetallics.

Applications will be passed upon late in April.

—Milnor Roberts, *Dean, College of Mines, University of Washington, Seattle, Wash.*

CERAMIC SHORT COURSE AT OHIO STATE UNIVERSITY

November 3 to 5, 1937

Owing to abnormal industrial activity in ceramics which will prevent many interested persons from being absent from the plants, it has been decided to postpone the biennial Short Course at Ohio State University until November and to schedule a Symposium on several phases of ceramic manufacture which at this time are of special interest to the entire industry.

The time chosen for this Symposium is Wednesday, Thursday, and Friday, November 3, 4, and 5, 1937. The Friday session will be in conjunction with the technical session of the Annual Meeting of the Ohio Ceramic Industries Association. The general session of O.C.I.A. will be on Saturday morning, November 6, followed by the Indiana-Ohio State football game Saturday afternoon.

All divisions of ceramics will be included in this Symposium except vitreous enamels, which will be provided at a separate time under the direction of the Porcelain Enamel Institute.

—Arthur S. Watts, *Chairman, Ceramic Engineering Department*

SPECIAL SUMMER COURSE IN CERAMICS ON "NATURE OF CLAY AND PLASTICITY"

Massachusetts Institute of Technology, July 12-17, 1937

The Department of Mining and Metallurgy, Massachusetts Institute of Technology, has announced a special summer course in ceramics on the "Nature of Clay and Plasticity." The course will be held from Monday, July 12, through Saturday, July 17.

Clay, the basic material of the ceramic industry, has been used for many thousands of years. Until recently, however, we have had only a vague idea of the cause of the clay-like properties. Thanks to the recent advances in the study of the clay minerals, we now have a much better understanding of the nature of clay. It is the purpose of this course to form as clear a picture as possible of clay and its relation to the water with which it is mixed. To do this, the subject will be discussed from several points of view by specialists who are authorities in their own fields.

The hours from 9:00 A.M. to 11:00 A.M. will be devoted to one lecture each day by an outstanding authority on clays and their properties. From 11:00 A.M. until noon, a discussion hour will be held. Laboratory and informal conferences will be held in the afternoon.

Lectures and Speakers Chosen

Monday, July 12: "The Origin of Clays in Nature"
By Wilber Stout, State Geologist, Columbus, Ohio
Tuesday, July 13: "The Clay Minerals, Their Properties, Occurrence, and Identification"
By C. S. Ross, U. S. Geological Survey, Washington, D. C.
Wednesday, July 14: "Clay from the Viewpoint of the Colloid Chemist"
By E. A. Hauser, Massachusetts Institute of Technology
Thursday, July 15: "Base Exchange Properties of Clays and Deflocculation"
By E. A. Hauser
Friday, July 16: "Atomic Structure of the Clay Minerals"
By B. E. Warren, Massachusetts Institute of Technology
Saturday, July 17: "The Nature of Plasticity in Clays"
By F. H. Norton

The laboratory experiments are designed primarily to familiarize the student with modern apparatus for measuring the properties of clays. The following experiments will be made available:

(1) The measurement of plasticity by stress-strain diagrams in torsion, with newly developed apparatus.

(2) The measurement of particle size by sedimentation and the determination of the correction factors for non-spherical particles.

(3) The continuous measurement of drying shrinkage.

(4) The measurement of heat adsorption or evolution in clay as a means of identification.

(5) The high-speed centrifuge for determining the colloidal fraction of a clay.

(6) Dialysis of a clay to determine the adsorbed salts.

Tuition and Living Facilities

The tuition fee for this course will be $30.00, which includes a $5.00 registration fee. As the number admitted to this course must be limited, it is suggested that applications be sent in at an early date.

Dormitory facilities for men are available on the Institute Campus during the summer at $4.00 per week. Dining facilities are available in Walker Memorial with cafeteria service, and restaurants and boarding places are close at hand.

Requests for information regarding this program should be addressed to F. H. Norton, Department of Mining & Metallurgy, Massachusetts Institute of Technology, Cambridge, Massachusetts.

PRESS REPORT OF EXHIBIT OF AMERICAN CERAMICS IN COPENHAGEN*

By Anna Wetherill Olmsted

The Copenhagen press was unanimous in recognizing the advanced stage of the ceramic art in America as represented by the preview of contemporary American ceramics assembled for exhibition in Copenhagen in the Museum for Industrial Art. American artists have made progress within all fields of this industry.

The Exhibition, which has been arranged and assembled by the Syracuse Museum of Fine Arts in Syracuse, N. Y., with financial assistance from the Rockefeller Foundation, has been sent abroad under the sponsorship of the American Ceramic Society. The Syracuse Museum is the only museum in the United States featuring annual national ceramic exhibitions devoted exclusively to ceramics.

Nationaltidende says that there is every reason to study this Exhibition with interest. This is the first time in the history of American art that an exhibition of contemporary American ceramics has been sent abroad upon official invitation from a foreign museum. The first invitation was received from the Kunstindustri (Arts and Crafts) Museum in Copenhagen which, from an American viewpoint, holds a leading position in industrial art, followed by similar invitations from the Arts and Crafts Museum in Gothenburg, Sweden; the Swedish National Museum in Stockholm; Helsingfors, Finland; and an invitation has been also received by the Syracuse Museum to send the Exhibition to the famous Hanley Museum in Stoke-on-Trent in the heart of the potteries of England (in Wedgwood's own town).

Ceremonious Opening of the Ceramics Exhibition[1]

The Exhibition of American ceramic ware was opened in the Kunstindustri Museet with a small ceremony. Director Slomann bid welcome on behalf of the Kunstindustri Museet to the American guests and the American Exhibition and expressed his delight that Denmark was given an opportunity to become acquainted with American art.

The American Charge d'Affaires, Mr. Winship, declared the Exhibition opened for inspection, stating that he considered it a good omen for the understanding between America and Denmark that this American Ceramic Exhibition, the first time it was taken abroad, was shown in Denmark. "It is indeed a privilege and pleasure for me to participate in this ceremony which initiates the forging of another link in the friendly relations so happily existing and materially furthers the sympathy and understanding between Denmark and the United States.

"You will perhaps be interested to know that since 1920 a tremendous art renaissance has swept the United States. It is not alone in painting and sculpture that one is apprised of this great development but in industrial art as well, and the remarkable results attained in ceramics are largely due to the initiative and energy of the ceramist, Mr. Cowan, founder of the Cowan Pottery in Ohio. He had the vision to create a noncommercial art department for individual artistic development which is unexcelled."

The American Ceramic Exhibition now placed on view represents only 160 pieces of the extensive collection assembled by the Syracuse Museum. Five years ago this Museum invited specimens of ceramics from our forty-eight states for their collection. The first invitation brought responses from eleven states; but now, only five years later, twenty-six states have responded, and a very high standard for acceptance is maintained. The States leading in ceramics at present are New York, Ohio, Michigan, and New Mexico.

[1] *The Press*, January 13, 1937.

* From the American Consulate, Copenhagen, Denmark. Received March 13, 1937.

—*Director*, Syracuse Museum of Fine Arts, Syracuse, N. Y.

ANNUAL MEETING PORCELAIN ENAMEL INSTITUTE

Members of the Institute of Vitreous Enamelers of England will be special guests of the Porcelain Enamel Institute at its seventh annual meeting in Chicago, October 12 to 13, 1937. Institute projects, discussed and approved by the executive committee recently, were as follows: (1) renewal of the research fellowship at Ohio State University, (2) "Porcelain Enamel Week," (3) architectural research, (4) the creation of an associate membership, (5) the research and market development activities of the Educational Bureau, and (6) the "Porcelain Enamel Institute Forum."

The fellowship at Ohio State University, which was awarded last year to George T. Rankin, will continue for another year as a result of a donation for this purpose from the Chicago Vitreous Enamel Product Company, Cicero, Ill. R. M. King, technical adviser to the Institute, reported that Dr. Rankin's research is progressing along highly constructive lines. The first year of the research fellowship, which has just ended, was financed by a donation from a friend of the Ferro Enamel Corp., Cleveland, Ohio.

Plans for a nation-wide "Porcelain Enamel Week," which will be observed by all companies manufacturing porcelain enamel or porcelain enameled products, were discussed by the committee, and the tentative plan was approved.

One of the Institute's newest and most important projects, the Porcelain Enamel Institute Forum, will be conducted at the University of Illinois, May 5, 6, and 7, 1937.* Mr. Hodek pointed out that the Forum will be conducted at Ohio State University in 1938 and will rotate between the two universities thereafter. Other members of the committee are A. I. Andrews, University of Illinois, J. E. Hansen, Ferro Enamel Corp., and R. M. King, Ohio State University.

SILICA RESEARCH INCLUDED IN VISITS TO EUROPEAN LABORATORIES

Industrialists to Sail May 14

American industrialists will have an opportunity to observe developments in European silica research this summer during a unique tour of scientific laboratories being arranged by the National Research Council's Division of Engineering and Industrial Research. About one hundred prominent bankers and industrialists, including leaders in the silica industry, are expected to participate in the tour. Of particular interest will be a visit to the Kaiser-Wilhelm Institut für Silikatforschung und für Faserstoffschemic. Visits to such world-famous institutions as the Cavendish Laboratories of Cambridge in England, the National Physical Laboratory in England, and the Conservatoire National des Arts et Métiers in France will also be included in the itinerary. Excursions may be arranged to nearby places of interest and beauty such as the city of Meissen, Germany, where china is made.

Research laboratories of eighteen major fields of industry will be visited in England, France, and Germany, besides those of trade associations, governments, and universities. In addition, accommodations will be made on the request of any member of the tour for special side trips to industrial laboratories not included in the general plans. Foreign hosts will be such organizations as the Department of Scientific and Industrial Research in England, the Verein Deutscher Ingenieure in Germany, the Sorbonne in France, and others.

The group will sail May 14 from New York on the S. S. Champlain, and the travel arrangements are being made by the American Express Company.

During the past fifteen years, Maurice Holland, director of the Division of Engineering and Industrial Research of the National Research Council, has been visiting countries in all parts of the world, wherever an industry has made strides in technology, and from his recent findings he believes this tour, "behind the scenes in industrial Europe," will have particular significance for American industry and will prove to be a definite stimulus for greater industrial development in the United States.

FOUNDRYMEN'S ASSOCIATION ANNUAL MEETING

Industrial Hygiene to Be Discussed

At the Annual Convention of the American Foundrymen's Association, to be held in Milwaukee, May 3 to 7, considerable time will be devoted to safety and hygiene as it relates to the foundry industry.

Two codes have been developed recently and published by the A.F.A. Industrial Hygiene Codes Committee, of which J. R. Allan, International Harvester Co., Chicago, is chairman, covering (1) Tentative Code of Recommended Practices for Testing and Measuring Air Flow in Exhaust Systems, and (2) Tentative Code of Recommended Practices for Grinding, Polishing, and Buffing Equipment Sanitation.

It is the intent of this Committee to develop further codes. The following papers will be presented May 3 to 7:

(1) "Eye and Respiratory Protection in the Foundry"
JOHN HOLZBOG, Personnel Manager, Chain Belt Co., Milwaukee, Wis.

(2) "Foot and Leg Protection in the Foundry"
M. WALTER DUNDORE, Production Manager, Beloit Iron Works, Beloit, Wis.

(3) "Safety as Effected by Maintenance"
JAMES THOMSON, Chief Engineer, Continental Roll & Steel Foundry Co., East Chicago, Ind.

(4) "Good Housekeeping in the Foundry"
E. G. MEITER, Director Industrial Hygiene Lab., Employers Mutual Liability Insurance Co., Milwaukee, Wis.

NEW USES OF SPODUMENE

A little-known, little-used mineral with the unlovely name of "spodumene" is going to be put to work through a process developed by the U. S. Bureau of Mines, Department of the Interior, to serve mankind in the air-condition-

* An announcement of this Conference was published in *Bull. Amer. Ceram. Soc.*, **16** [1] 24 (1937).

ing of buildings, the making of better pottery, and in the production of lithia water, storage batteries, and special types of extremely tough glass. The largest reserves of spodumene are in South Dakota, North Carolina, and Maine.

Technologists at the Nonmetallic Minerals Experiment Station of the Bureau of Mines have found that the spodumene mineral, if heated in a lime kiln, will be converted to a chalky white mass that can be crumbled between the fingers while all the other minerals present in the ore remain strong.

The fine dust resulting from this treatment is about 80 to 90% pure, and from many localities this product will be of acceptable purity. It is much better adapted to use in making lithium chloride than the original hard, dense spodumene. It is also ready to be used in a glass batch, unless nature happened to put magnetic iron minerals in the ore, in which case a preliminary removal of iron minerals would be needed. The pottery makers have tried to use spodumene, but it has been unacceptable because at the temperature of a lime kiln it tends to expand and tear pottery to pieces. The beta-spodumene, formed by the heating and now to be sifted out of the heated ore, has already been expanded and does not have this disadvantage. Therefore potters are urged to forget ordinary spodumene and to try beta-spodumene.

Spodumene is the most plentiful of the lithium-bearing ores. It looks and behaves much like feldspar. Lithium and lithium salts, heretofore extracted from less common and more expensive ores, now promise to have several important new uses. Lithium chloride solutions, for instance, should find greatly increased use in the conditioning and drying of air in the fast-growing air-conditioning industry.

Details are given in *Report of Investigations*, No. 3336, "Beneficiation of Spodumene by Decrepitation," by Oliver C. Ralston and Foster Fraas. Copies may be obtained from the U. S. Bureau of Mines, Washington, D. C.

PITTSBURGH-CORNING CORPORATION FORMED

Corning Glass Works and Pittsburgh Plate Glass Company have formed a new corporation to be called the Pittsburgh-Corning Corporation, which will deal exclusively with the development, manufacture, and sale of certain types of glass for the architectural and building fields. The new Corporation will supply glasses commonly known as structural or architectural glass, such as glass block, glass tile, colored Carrara structural glass, and molded glass, types which are being increasingly used in the construction of houses, store fronts, office buildings, and factories. The current trend toward glass construction is apparent in this year's extensive plans of building operations throughout the United States. The formation of the new Company is not a merger of the Pittsburgh Plate Glass Company and the Corning Glass Works. The purpose is to create a joint corporation for the advancement of glass in the building industry, without affecting the diversified interests of either company in their other fields of glass manufacturing.

Commenting upon the formation of the new company, its President, Harry S. Wherrett, also President of Pittsburgh Plate Glass Company, says that the Pittsburgh-Corning Corporation will offer a coördination of research, engineering, and distribution experience of unparalleled scope. Corning Glass Works is recognized as the outstanding manufacturer of technical glass products, and Pittsburgh Plate Glass Company as the largest plate glass producer. Both companies have been long established in the glass business.

Mr. Wherrett states that the new company will make available to architects and builders the latest technical achievements in architectural fields. The Pittsburgh system of seventy warehouses throughout the United States has brought invaluable experience in serving the building industry with window glass, plate glass, and related products of every description. Pittsburgh-Corning will receive the benefit of this territorial system for distribution of glass to the building trades.

Amory Houghton, President of Corning Glass Works, and Chairman of the Board of the new Company, explains

Harry S. Wherrett, President, Pittsburgh Plate Glass Co.

that Corning has been active for some time in the development of glass construction units, sometimes referred to as glass brick or block. Corning is erecting in New York City, the first office building in which glass walls replace the ordinary brick wall and glass window construction.

GRADUATES OF COLLEGES AND SCHOOL OF PRACTICAL EXPERIENCE

Your *Class Room Days* are over
Your Compulsory Technical Reading is at an End

BUT . . .

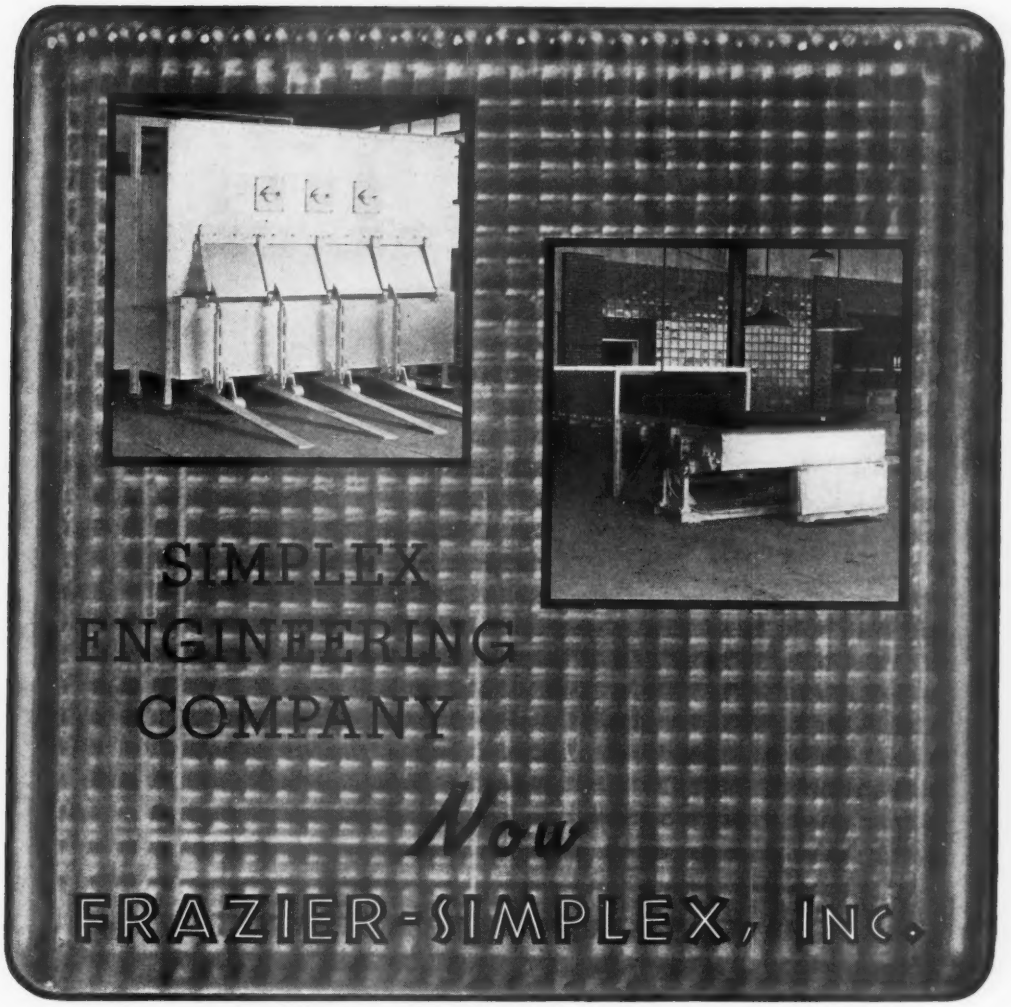
Your *Education* is Only *Beginning*

The American Ceramic Society offers you new educational tools to replace professors, classrooms, and libraries

(*1*) *Meetings*
(*2*) *The Journal of the American Ceramic Society*
(*3*) *Ceramic Abstracts*
(*4*) *The Bulletin*
(*5*) *Bibliographies*

Let your new employer know that your studies are being continued through this means

THE AMERICAN CERAMIC SOCIETY
2525 NORTH HIGH STREET, COLUMBUS, OHIO



Same Company...*Same* Officers...*Same* Personnel...*Same* Engineers...*Same* Service...BUT *New Name*

▼

FRAZIER-SIMPLEX, INC.

ENGINEERS

Washington Trust Building . . . Washington, Penna.

PEMCO
THE WORLD'S FINEST

Continuous UNIFORM *Smelting*
PERFORMANCE
FOR
CONTINUOUS FURNACES

In enameling departments, continuous furnaces can operate at peak efficiency only if porcelain enamels are of POSITIVE UNIFORMITY.

Continuous smelting is the ONLY method of producing PORCELAIN ENAMEL GROUND AND COVER COAT FRITS OF POSITIVE UNIFORMITY. PEMCO operates the only Continuous Smelters in the world.

Make your continuous furnaces CONTINUOUS ALL THE TIME with Pemco Continuously Smelted Frits.

THE PORCELAIN ENAMEL AND MANUFACTURING CO.
Eastern & Pemco Avenues, Baltimore, Md., U. S. A.

SOLVAY
TRADE MARK REG. U. S. PAT. OFF.
dustless dense
SODA ASH

Made Especially for the Glass Maker

Specify SOLVAY when you buy Soda Ash because Solvay is and has been the standard of quality since 1881. It offers the following advantages:

1. More than 99.50% Sodium Carbonate (dry basis).
2. Proper granulation and absolute uniformity in quality.
3. Your choice of Soda Ash graded for efficient use with any of the known commercial glass sands.
4. The services of a well organized technical staff which is available to Solvay customers.

Make Solvay your source of supply for
DUSTLESS CALCINED 98-100%
POTASSIUM CARBONATE
Hydrated 83-85% Potassium Carbonate
Ground Caustic Potash

Full information sent on request.
SOLVAY SALES CORPORATION
Alkalies and Chemical Products Manufactured by The Solvay Process Company
40 RECTOR ST. NEW YORK

FLINT

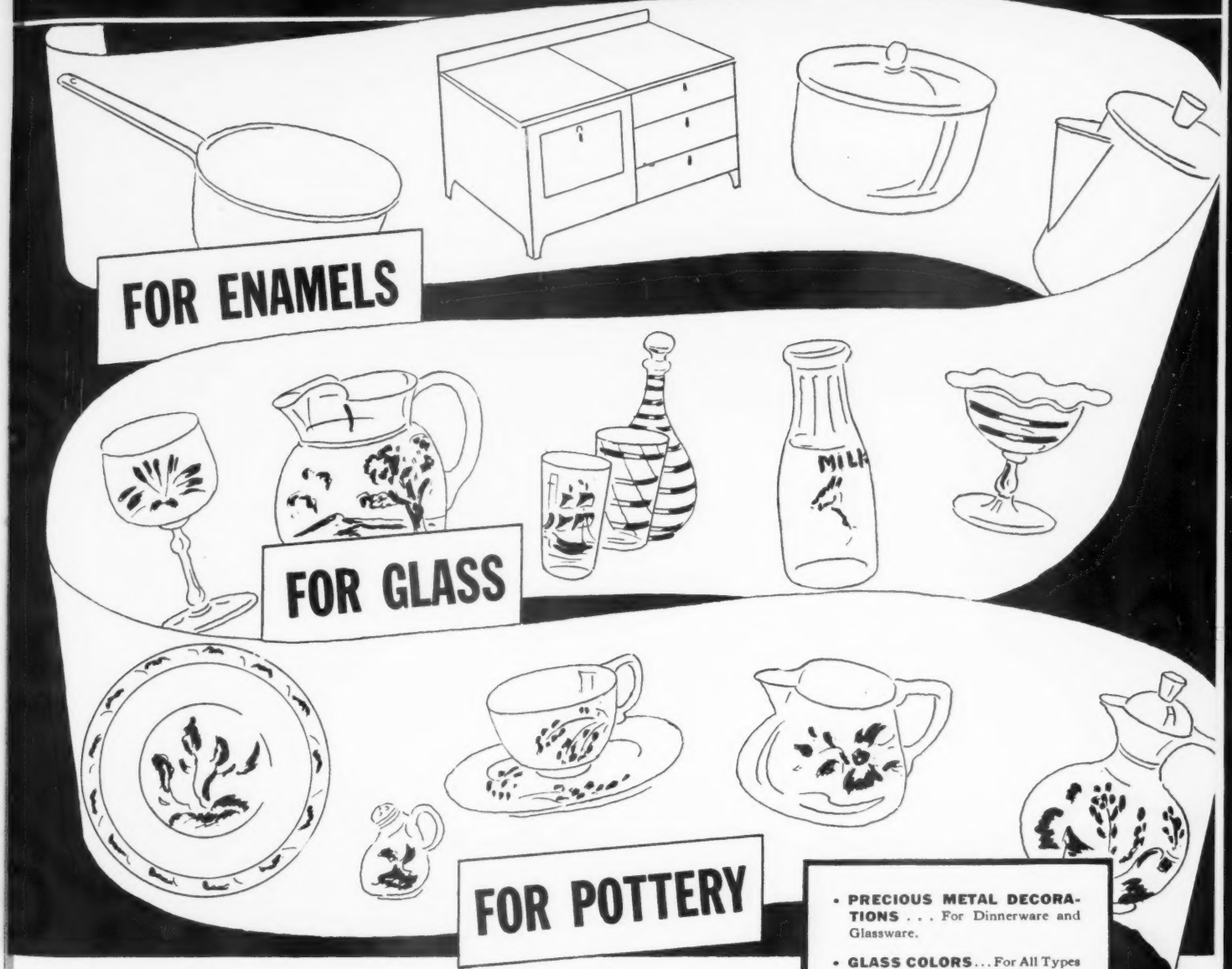
PAPER MAKERS IMPORTING CO. INC. EASTON, PENNSYLVANIA, U.S.A.

FINEST POTTERY CLAYS

TALC WHITING

DU PONT
REG. U.S. PAT. OFF.

COLORS *and* DECORATIONS



- **PRECIOUS METAL DECORATIONS** . . . For Dinnerware and Glassware.
- **GLASS COLORS** . . . For All Types of Glassware Decorations.
- **BODY, SLIP AND GLAZE STAINS** . . . (Over and Underglaze) for Pottery, Tile, and Heavy Clay Products.
- **COLOR OXIDES** . . . For Porcelain Enamels.
- **TIN OXIDE** . . . A Trouble-Free Opacifier for General Use.
- **RAW MATERIALS.**

Write to the nearest of the offices listed below, or direct to Perth Amboy, for prices and further details on specific items.

IF IT'S STANDARD, DU PONT HAS IT!

IF IT'S "SPECIAL," WE'LL MAKE IT!

To give your product the air of distinction which brings bigger sales, use du Pont's *pre-tested* Colors and Decorations. Pre-testing assures you uniform, *full color* from lot to lot.

Our complete line of colors and decorations includes practically every decorating material: standard and special-match colors for ceramics and glassware, precious metal decorations, overglazes, underglazes, color oxides, and other ceramic materials.

Take advantage of our complete technical service which is backed by 50 years of experience. Write for complete details about du Pont pre-tested Colors and Decorations.

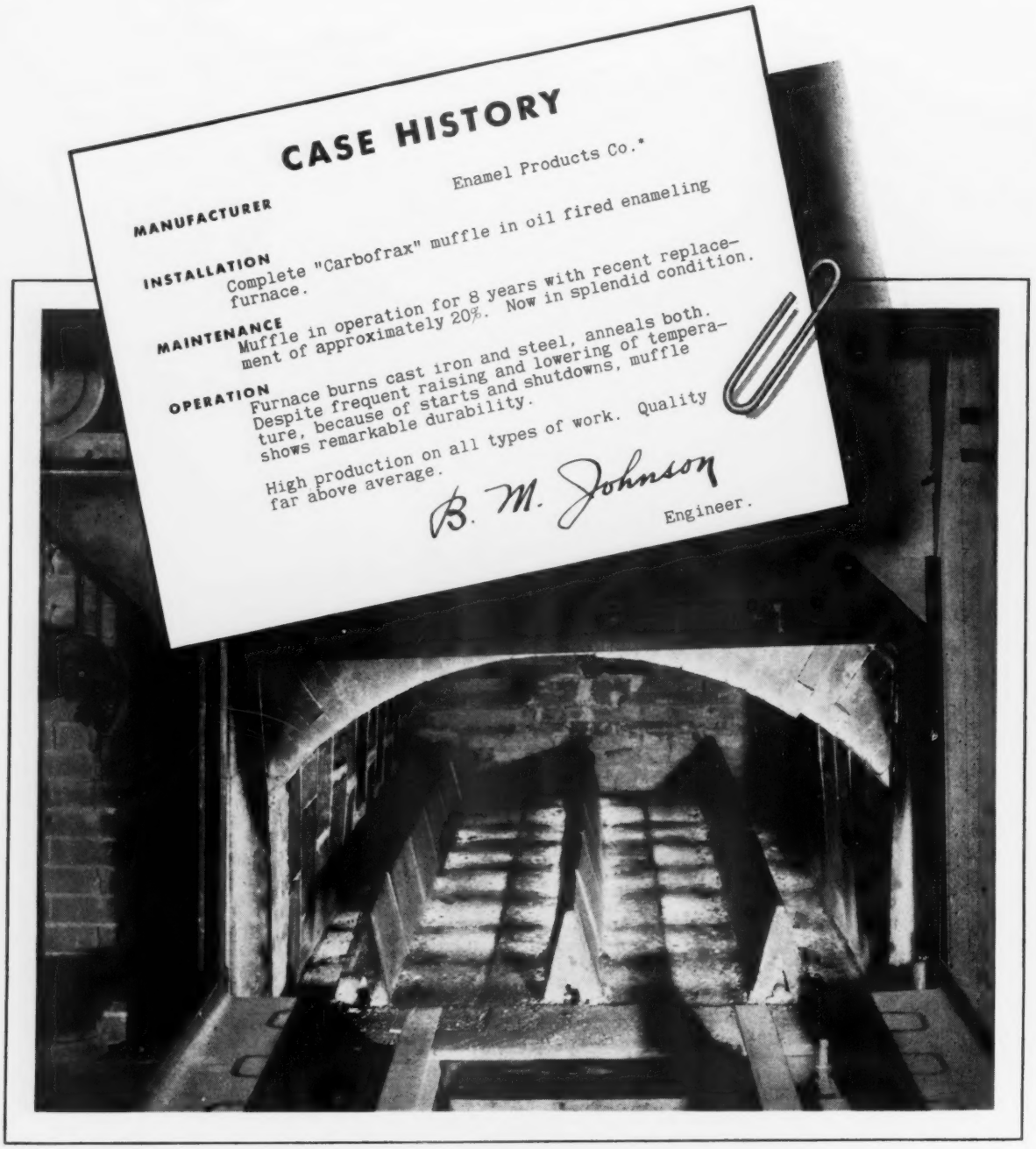
THE R. & H. CHEMICALS DEPT., E. I. DU PONT DE NEMOURS & COMPANY, Inc.

Ceramic Products Division, Wilmington, Delaware

DU PONT

District Sales Offices: Baltimore · Boston · Charlotte · Chicago · Cleveland
Kansas City · Newark · New York · Philadelphia · Pittsburgh · San Francisco

Sales Agent: L. Reusche & Company, Newark, N. J.


CASE HISTORY
MANUFACTURER
Enamel Products Co.*
INSTALLATION
Complete "Carbofrax" muffle in oil fired enameling furnace.
MAINTENANCE
Muffle in operation for 8 years with recent replacement of approximately 20%. Now in splendid condition.
OPERATION
Furnace burns cast iron and steel, anneals both. Despite frequent raising and lowering of temperature, because of starts and shutdowns, muffle shows remarkable durability.
High production on all types of work. Quality far above average.
B. M. Johnson
Engineer.

* Name on application.

TUNE IN THE CARBORUNDUM BAND
Saturdays at 7:30 P.M., E.S.T.
Columbia Chain

REFRACTORY CARBORUNDUM BRAND PRODUCTS

THE CARBORUNDUM COMPANY, REFRACTORY DIVISION, PERTH AMBOY, N. J.

REG. U. S. PAT. OFF.

District Sales Branches: Boston, Chicago, Cleveland, Detroit, Philadelphia, Pittsburgh. Agents: McConnell Sales and Engineering Corp., Birmingham, Ala.; Calvin M. Christy, St. Louis; Harrison & Company, Salt Lake City, Utah; Pacific Abrasive Supply Co., Los Angeles, San Francisco, Seattle; Denver Fireclay Co., El Paso, Texas.
(Carborundum and Carbofrax are registered trade-marks of The Carborundum Company.)

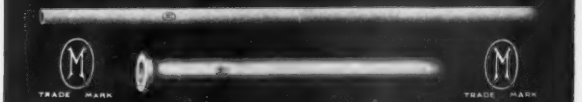
THE HOUSE OF HOMMEL
SUPPLIERS OF ALL CERAMIC NEEDS

Quality
FRITS
COLORS
CHEMICALS
Stocked for
IMMEDIATE
SHIPMENT

THE
O. HOMMEL CO.
Quality First · Since 1891
209 Fourth Avenue Pittsburgh, Pa.
LET OTHERS IMITATE -:- WE ORIGINATE

Pacific Coast Agents
L. H. BUTCHER CO.
Los Angeles - Salt Lake City - San Francisco - Portland - Seattle

MONTGOMERY PORCELAIN PRODUCTS COMPANY
SPECIALIZING IN
Primary Protection Tubes for all makes of Pyrometers

MONTGOMERY

PYROMETER TUBES

CORUNDUM REFRACTORY PORCELAIN MULLITE
SILICON CARBIDE

When you're Sick you Consult a Specialist.
On the same basis, when you need Pyrometer Tubes,

CONSULT
MONTGOMERY PORCELAIN PRODUCTS CO.
FRANKLIN OHIO

Ceramic Service?
We Give It

We Manufacture—
Pins
Stilts
Thimbles
Spurs
Saggers
Crucibles
Tile for Decorating Kilns

We Sell—
Ball Clay
Sagger Clay
Wad Clay
Ground Fire Clay
Bitstone
Fire Brick
Imported Paris White
Domestic Whiting
Pottery Plaster
Georgia Kaolin

THE POTTERS SUPPLY COMPANY
EAST LIVERPOOL, OHIO

McDANEL REFRACTORY PORCELAIN COMPANY

Manufacturers of

PORCELAIN TUBES PROTECTION TUBES
INSULATING TUBING and BEADS

BEAVER FALLS PENNSYLVANIA

THREE ELEPHANT

BORAX

REG. U.S. PAT. OFF. REG. U.S. PAT. OFF.

AND BORIC ACID

GUARANTEED OVER 99.5% PURE

AMERICAN POTASH & CHEMICAL CORPORATION

70 Pine Street, New York

CLAYS

English China and Ball

TALCS

for

HEATING ELEMENTS
CERAMIC BODIES
SAGGER USES

Ceramic Specialties Include

Whiting : Paris White : Magnesite
Cornwall Stone : Barium Carbonate
Zinc Oxide : Enameling Clays : Etc.

HAMMILL & GILLESPIE, INC.

Importers since 1848

225 Broadway New York

Ceramic Kilns and Furnaces

Complete Equipment
Designed
Built
Operated

Our broad experience is at your service.

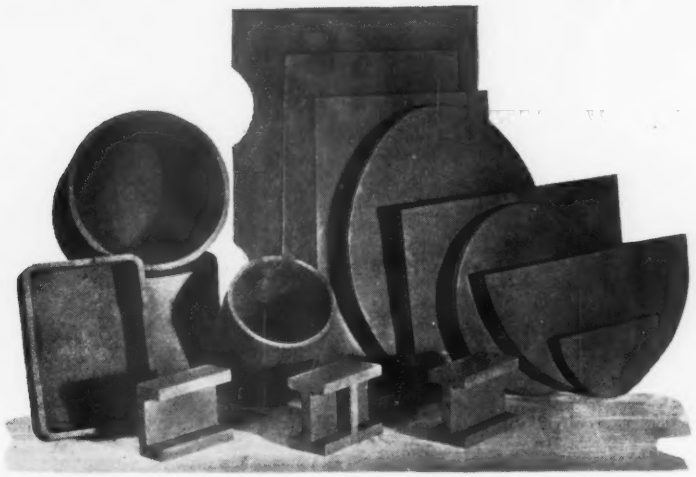
We represent the Ferro Enamel Corporation, Cleveland, Ohio, as sales agents for its complete and successful line of ceramic glazes.

ALLIED ENGINEERING COMPANY

4150 E. 56th STREET CLEVELAND, OHIO

(A SUBSIDIARY OF FERRO ENAMEL CORPORATION, CLEVELAND, O.)

ELECTRO'S SILICON CARBIDE



Processed especially for YOUR kiln conditions

KELLOGG AA
Batts and Saggers
for { China Ware, Pottery, Sanitary Ware, Vitrified Porcelain, Abrasive Ware, Vitrified Tile, Stone Ware

NON-GRO
Brick and Tile
for { Porcelain Enamel Muffles, Glass Lehrs

THE ELECTRO REFRACTORIES & ALLOYS CORPORATION
Andrews Building Buffalo, New York.

The Harris Clay Company

Refiners of fine N. C. Kaolin since 1888

ANNOUNCES

Introduction to the Ceramic Industry

of

"HARRIS LUNDAY"

A *PLASTIC* North Carolina Kaolin combining the best properties of English China Clay and Domestic Primary Kaolins.

Two Years in the making
Now Ready for Delivery

We can Guarantee Uniformity
because we Control Every Step

IF YOU USE CLAY IN YOUR BODY "HARRIS LUNDAY" WILL IMPROVE IT

We will gladly furnish the clay if you will give it a trial

HARRIS CLAY COMPANY

Main Office: DILLSBORO, N. C.

Mines: SPRUCE PINE, N. C.

North Carolina Feldspar
North Carolina China Clay
Georgia China Clay
Georgia Saggar Clay
Pulverized Saggar Grog
Broken Saggars
Broken Bisque & Porcelain

RICHARD C. SANT

EAST LIVERPOOL,
OHIO

Representing:

North Carolina Feldspar Corp.
Carolina China Clay Co.
Boyd & Sant Clay Co.
John Sant Company

HARTFORD-EMPIRE COMPANY

HARTFORD, CONN.

Engineers and Licensors

FEEDERS FORMING MACHINES CONVEYORS
STACKERS LEHRS

ORTON STANDARD PYROMETRIC CONES

For Forty Years
The American Standard for
Control of Ceramic Heat Treatment

THE EDWARD ORTON, JR.,
CERAMIC FOUNDATION
George A. Bole, D.Sc., *Manager*

Laboratories & Office
1445 Summit Street—Columbus, Ohio

OFFICIAL AMERICAN CERAMIC SOCIETY EMBLEM

10 K. Solid Gold—$6.50
20 Year Gold Filled—$3.25

Order directly from the

AMERICAN CERAMIC SOCIETY
2525 N. High St., Columbus, Ohio

Be sure to enclose check or money order for full amount

LOCATE THE CAUSE OF STRAIN

Strain is clearly visible when viewed through a B & L Polariscope. By systematic examinations of the glass with a Polariscope, you can readily determine whether the strain is caused by standing too long between the molding machine and the lehr, faulty temperature, or spotty conditions in the lehr.

The strains can be located, marked, and the degree estimated. With all of this information on hand, you can easily locate the cause of your trouble and take steps to eliminate it.

For complete details on the B & L Polariscope, write for Booklet D-214 to Bausch & Lomb Optical Co., 654 St. Paul St., Rochester, N. Y.

BAUSCH & LOMB

....WE MAKE OUR OWN GLASS TO INSURE STANDARDIZED PRODUCTION

FOR YOUR GLASSES INSIST ON B & L ORTHOGON LENSES AND B & L FRAMES...

BETHLEHEM PRODUCTS

for the Ceramics Industry

88-80 CASTINGS

to save maintenance on grinding equipment

BETHLEHEM ABRASIVE-RESISTING PLATES

for chutes, hoppers, dump-car bottoms

BETHLEHEM TOOL STEEL

for dry press and repress liners

BETH-CU-LOY SHEETS

for long lasting roofing and siding

Also—Light Rails, Steel Ties and Track Equipment;
Steel Bars and Kiln Bands; Boiler Tubes

BETHLEHEM STEEL COMPANY

General Offices BETHLEHEM STEEL **Bethlehem, Pa.**

District Offices: Albany, Atlanta, Baltimore, Boston, Bridgeport, Buffalo, Chicago, Cincinnati, Cleveland, Dallas, Detroit, Honolulu, Houston, Indianapolis, Kansas City, Los Angeles, Milwaukee, New York, Philadelphia, Pittsburgh, Portland, Ore., Salt Lake City, San Antonio, San Francisco, St. Louis, St. Paul, Seattle, Syracuse, Toledo, Washington, Wilkes-Barre, York.
Export Distributor: Bethlehem Steel Export Corporation, New York

Product Finish Insurance

THERE is satisfaction in knowing that the frit you buy is of the finest quality and that the service is dependable.

There is greater satisfaction in knowing that the frit is *uniformly* fine and that the service is *consistently* dependable.

When you buy Lusterlite Frit you buy *product finish insurance.*

CHICAGO VITREOUS ENAMEL PRODUCT CO.
CICERO ILLINOIS

LUSTERLITE ENAMELS

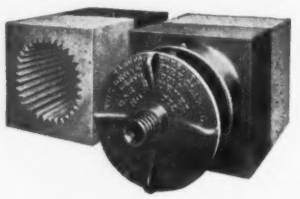
OK'ed by the most severe service conditions

DFC TYPE A GAS BURNERS

.....are piling up remarkable records, in the ceramic industry, for efficient firing, ease of operation, and freedom from maintenance costs.

They have no direct-exposed metal parts to burn out. Refractory nozzles are high-alumina material, and can be subjected to innumerable burns up to the top limits of highest quality fire clay brick.

Flame propagation is exceptionally rapid—resulting in large capacity per size of burner. Flames will not blow off, regardless of length. Built in wide range of sizes.



WRITE FOR BULLETIN 305A

complete data on capacities, operating advantages, and performance.

The DENVER FIRE CLAY Company
EL PASO, TEXAS · NEW YORK, N.Y. · DFC · SALT LAKE CITY, UTAH
DENVER, COLO., U.S.A.

H. C. SPINKS CLAY COMPANY

Miners and Shippers of

BALL, SAGGER AND WAD CLAY

NEWPORT, KENTUCKY

New York
March 27, 1937

Mr. Pete Potter

Saucerville, Ohio

Dear Pete:

Well, everything at the Waldorf is "Comfortable"—but back to the mines to dig more JERNIGAN, CHAMPION & CHALLENGER!!! I am sure that the noise of the steam shovel will still be sweet music to my ears.

Glad you have gone over to look after dinnerware plant. With the insight that you had into body formulae and composition at the Waldorf Monday night, and at the meeting held at the French Casino last Wednesday night, you surely learned something about better, more beautiful, and straighter ware.

Someone always stands out as the best—so stick to the three best ball clays for quality ware and a profit—JERNIGAN, CHAMPION & CHALLENGER.

Sincerely,

Dick Carothers

General Manager
H. C. SPINKS CLAY COMPANY

MT and TIN OXIDE

for better glazes

METAL & THERMIT CORPORATION, 120 BROADWAY, NEW YORK, N. Y.